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**NCIX PC**

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SUPERIOR GAMING PCs.







NEXT GEN Z270 GAMING MOTHERBOARDS

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TRUE GAMING





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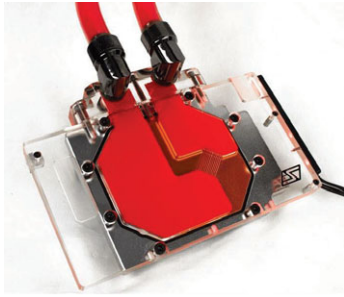
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## Swiftech Releases Komodo RX480 Waterblock For AMD Radeon Cards

Swiftech has released a new waterblock, the Komodo RX480, designed for graphics cards using AMD's Radeon RX 480 GPUs. The Komodo RX480 is a full-cover block that cools a card's memory and power regulation areas in addition to the GPU. According to Swiftech, the new Komodo waterblock includes an "advanced thermal design and low flow restriction" that combine to improve cooling performance. As a secondary benefit, the waterblock also provides added protection for the graphics card because it covers the entire PCB area. This strengthens the card and protects it from bending. The coverage also protects components on the card from bumps and scrapes that can occur when users are adding or removing other parts from their systems. The Komodo RX480 waterblock has an MSRP of \$99.95. Swiftech also sells a backplate (\$29.95), lighting strip (\$11.95), and light controller (\$12.95) as separate accessories for the waterblock.

## Corsair Speeds Up Storage With Force Series MP500 SSDs

CORSAIR has announced its fastest line of solid-state drives. The new Force Series MP500 drives use the M.2 2280 form factor and the NVMe flash storage protocol to transfer data at read speeds up to 3,000MBps and write speeds up to 2,400MBps. CORSAIR says the Force Series MP500 drives will come in 120GB, 240GB, and 480GB capacities. The 120GB version is already available on the company's website for \$109.99. (As we went to press, there was no word on pricing for the other sizes or how soon they will be available.) Along with a tiny form factor and blazing speed, the new drives come with proprietary technologies from CORSAIR that increase data reliability and protect data from being corrupted during sudden shutdowns or other power losses. The drives are compatible with Microsoft Windows, Mac OS X, and Linux, and they come with three-year warranties.



### WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

CPU	Released	Original Price	Last Month's Price	Online Retail Price*
AMD FX-9590 Eight-Core (Vishera)	6/11/2013	n/a	\$229.99	\$199.99
AMD FX-9370 Eight-Core (Vishera)	6/11/2013	\$375	\$222.35	\$219.99
AMD FX-8370 (Vishera)	9/2/2014	\$199.99	\$189.99	\$189.99
AMD FX-6350 (Vishera)	10/1/2012	\$132	\$134.99	\$134.99
AMD A10-7890K (Godavari)	3/1/2016	\$164.99	\$148.99	\$148.99
AMD A10-7870K (Godavari)	5/28/2015	\$137	\$129.99	\$145.69
AMD A10-7860K (Godavari)	2/2/2016	\$116.99	\$104.99	\$99.99
AMD Athlon X4 880K (Godavari)	3/1/2016	\$94.99	\$92.34	\$93.40
AMD Athlon X4 860K (Kaveri)	8/1/2014	\$94.99	\$69.99	\$64.99
AMD Athlon X4 845 (Carrizo)	2/2/2016	\$69.99	\$64.43	\$67.99
Intel Core i7- 6950X (Broadwell E)	5/31/2016	\$1,723**	\$1,649.99	\$1,649.99
Intel Core i7- 5960X Eight-Core (Haswell)	8/29/2014	\$999**	\$1,015.99	\$1,015.99
Intel Core i7- 6900K (Broadwell E)	5/31/2016	\$1,089**	\$1,089.46	\$1,049.99
Intel Core i7- 6850K (Broadwell E)	5/31/2016	\$617**	\$609.99	\$609.99
Intel Core i7- 5930K Six-Core (Haswell)	8/29/2014	\$583**	\$579.99	\$579.99
Intel Core i7-5820K Six-Core (Haswell)	8/29/2014	\$389**	\$389.99	\$389.99
Intel Core i7-6700K Quad-Core (Skylake)	8/5/2015	\$359**	\$349.99	\$339.99
Intel Core i7-4790K Quad-Core (D.Canyon)	6/25/2014	\$339**	\$339.99	\$339.99
Intel Core i7-4790 Quad-Core (Haswell)	5/11/2014	\$303**	\$304.99	\$304.99
Intel Core i5-6600K Quad-Core (Skylake)	8/5/2015	\$249**	\$239.99	\$229.99

\* As of December 2016

\*\* Manufacturer's estimated price per 1,000





## OWC Mercury Elite Pro Dual Mini Offers Powerful, Portable RAID

The Mercury Elite Pro Dual mini is a new portable dual-drive RAID option for users who need powerful, substantial mobile storage. The portable unit offers two drives with up to 2TB each (up to 4TB total capacity) that can be configured in either RAID 0 for more speed or RAID 1 for greater security. The unit also can be set up so the drives operate independently (JBOD) or in a Span configuration. OWC says the mini is among the first products in its class to offer drives that operate at USB 3.1 Gen 2 speeds. The unit can be purchased in eight different configurations and comes with either hard drives or SSDs. Pricing starts at \$228.99 for the 1TB hard drive unit and \$238.99 for the 240GB SSD configuration. In RAID 0, OWC says the Mercury Elite Pro Dual mini can read data at up to 738MBps and write at up to 650MBps. The unit can draw its power via the USB bus, so you can use it wherever you need extra storage.

## BIOSTAR Announces Its Second Gaming Mouse, The RACING AM3

BIOSTAR's RACING AM3 is the second mouse the company has produced and follows on the heels of the AM2, which was announced in September. The RACING AM3 is an ambidextrous mouse that features a PMW 3320 optical sensor with four adjustable sensitivity settings at 800; 1,200; 2,400; and 5,000 dpi. The mouse uses HUANO switches that are rated for 10 million clicks. It has a frame rate of 5,300fps and a tracking speed of 80ips. Large Teflon feet make for smooth maneuvering, and the mouse includes a braided nylon cable that is 1.8 meters long. BIOSTAR says its new mouse comes with RACING AM3 software that lets users customize buttons, change the polling rate, select among the predefined dpi settings, and define macros. The MSRP is just \$15.95.



## ASRock Updates The Beebox Line With 7th Generation Intel Core CPUs

ASRock announced its new Beebox-S Series of mini PCs will include a choice of Intel 7th Generation Core i3 or i5 CPUs. With the new Kaby Lake processor options, ASRock is promoting the Beebox-S as a home-theater PC that can drive 4K video playback. The Kaby Lake systems come in two versions. The Beebox-S 7200U includes an Intel Core i5 7200U processor, while the Beebox-S 7100U comes with an Intel Core i3-7100U CPU. Both Beebox models are otherwise identical and support up to 32GB of DDR4 2,133MHz RAM. They have one M.2 slot for storage and also can support another 2.5-inch SATA III hard drive. The systems also come with two HDMI and DisplayPort ports, 802.11 ac Wi-Fi, and one USB 3.1 Type-C connection. Pricing for the new barebones units starts at about \$300 for the 7100U.





## Spire Rolls Out New MicroATX Chassis Option, The Tricer 1411

Netherlands-based component manufacturer Spire has announced the Tricer 1411, a new microATX chassis for enthusiasts building small-form-factor rigs. The steel chassis measures just 14.9 x 6.7 x 14.6 inches (HxWxD) and includes a reinforced drive bay rack in front for optical drives, SSDs, or hard drives.

The compact case comes with one 120mm exhaust fan but has mounts inside for up to two 92mm and two 120mm fans. There are four expansion slots, and the side panels have thumb screws for easy removal. The front panel includes one USB 3.0, two USB 2.0, and HD/AC97 Audio connections.

The Tricer 1411 has an MSRP of just \$49.99.

### HARDWARE MOLE



## ASUS Announces Xonar U7 MKII

The Xonar U7 MKII from ASUS combines a 7.1 surround-sound card with a headphone amplifier and provides up to 192kHz/24-bit output. The unit comes in a small, attractive form factor with a large volume control knob on top. The audio card has a Cirrus Logic CS4398 DAC and includes ASUS Hyper Grounding technology, which reduces interference and improves signal clarity. ASUS claims the Xonar's 114db SNR (signal-to-noise ratio) provides up to 16 times the audio clarity of the typical PC setup, which has an average 90db SNR for onboard audio. ASUS also suggests that users with home surround-sound systems that lack HDMI inputs can use the analog or S/PDIF outputs on the Xonar U7 MKII to run their gaming audio through their home surround-sound setups.

## BitFenix Plans Whisper M PSU Line

BitFenix has a new line of PSUs coming soon under the name Whisper M. The new ATX power supplies are certified 80-PLUS Gold and will be available in 450-, 550-, 650-, 750-, and 850-watt capacities. The Whisper M comes with a 135mm FDB (fluid dynamic bearing) fan that BitFenix says will generate a noise level of less than 18dBA when the PSU is operating with a load of less than 60% at 25 degrees C. The intelligent fans start working at only 3.5v and at an extremely low RPM. The higher-wattage Whisper M models come with quad 12V rails (450W and 550W have three rails), and the rails have varying load limits. BitFenix says the GPU rails can handle higher current capacities. The power supplies are completely modular and come with flat ribbon cabling. No word yet on retail availability or pricing.







## Computers Could Someday “Explain” Their Decisions

While neural networks, which look for patterns in data to yield useful predictions or classifications, have proven successful at classifying data, they can't explain why they came to those conclusions, according to MIT. Researchers are working to solve that by developing a way to train the networks so they provide predictions and classifications along with rationales for their decisions. Initial research focused on textual data. Researchers divided a neural network into two modules: the first module takes segments of data and scores them according to length and coherence, and a second module takes those scores and performs the prediction or classification. By training the modules together, the goal is to maximize the score of the extracted data segments and the accuracy of the prediction or classification. These improved neural networks could have widespread possibilities, including medical decision-making and anywhere “the cost of making the wrong prediction is very high,” said MIT Professor Regina Barzilay.

## Facebook Bug Bounty Program Marks Fifth Year By Expanding

Facebook is celebrating the fifth anniversary of its Bug Bounty program. The program, which the company describes as providing recognition and compensation to security researchers practicing responsible disclosure, covers several Facebook features, products, and acquisitions, including Atlas, Instagram, Oculus, and Internet.org. In the five years since starting the bounty program, Facebook has awarded more than \$5 million to more than 900 researchers who spotted and reported bugs. In a recent blog post, Joey Tyson, a security engineer who works on the Facebook Bug Bounty team, said the company received more than 9,000 reports in the first six months of last year and awarded \$611,741 to 149 researchers. India, the United States, and Mexico were the top three countries receiving the largest number of payouts. Tyson said Facebook is always looking to improve and expand the program and this year added WhatsApp to the list of programs covered, expanded payment options to include Bitcoin, and switched to an automated payment process to pay researchers faster.



### SOFTWARE SHORTS

## Researchers Use Deep Learning To Improve Automated Lip Reading

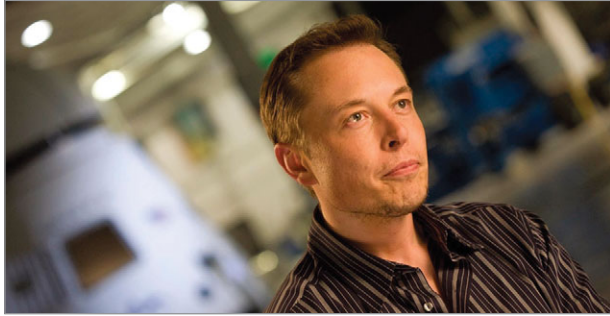
Lip reading is an important part of communication, but it's a notoriously difficult task for humans to master, and automated processes or machines have difficulty extracting the space and time features needed to be successful, according to researchers at the University of Oxford. But a new lip-reading system being developed by the Department of Computer Science has surpassed both humans and previous automatic lip-reading systems. The LipNet software makes use of spatiotemporal (space/time) movements, an LSTM recurrent network, and other elements to map a variable-length sequence of video frames to text and make sentence-level predictions.



Unlike previous lip-reading programs, which focus on word classification, LipNet is the first to provide sentence-level sequence prediction, the researchers note. In testing on the GRID corpus, LipNet reached sentence-level word accuracy levels of up to 93.4%; hearing-impaired people who can read lips are known to achieve accuracy levels of up to 52.3%.

The researchers note that machine lip readers have enormous potential in hearing aid development, covert conversations, speech recognition in noisy environments, and other areas. Although LipNet has shown great potential, the researchers point out that development is in the early stages. The test dataset covered short, formulaic videos with a well-lit person face-on, the researchers say, so a next logical step is to improve the system to work on more challenging video footage.





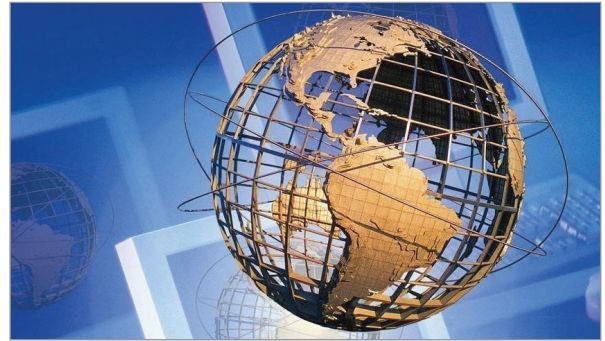
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## Elon Musk Moves SpaceX's Plans One Step Closer To Blastoff

Generally slower than most forms of terrestrial internet access with the exception of dial-up, satellite internet usually only finds favor with users who don't have access to traditional broadband options. If anyone can change that, though, it's Elon Musk, whose company SpaceX recently filed an application with the FCC to put more than 4,000 satellites into orbit around Earth, building a new high-speed internet network. Phase one of Musk's plan involves establishing a network of 800 low-orbit satellites to supply high-speed internet access to the contiguous United States, plus Hawaii, Puerto Rico, and the U.S. Virgin Islands (sorry, Alaska). As the deployment of SpaceX's satellites ramps up, global coverage should be possible. The satellites will camp out in Earth's orbit anywhere from about 715 to 823 miles above the Earth's surface, which puts them beyond the International Space Station but not nearly as far out as geostationary satellites.

## High Number Of Millennials Falling Victim To Tech Support Scams

A new report by Microsoft shows some rather startling results regarding tech support scams. Among those stats? Nearly two-thirds of users globally have experienced a tech support scam in the past 12 months, and while 17% of victims were 55 or older, 50% were between 18 and 34 years old and 34% were between the ages of 36 and 54. In an article discussing the report, Courtney Gregoire, a senior attorney in Microsoft's Digital Crimes Unit, said that, although those numbers challenge many preconceived notions that fraudsters target senior citizens, the research also shows that fraudsters are evolving their tactics, using pop-ups, unsolicited email, and scam websites as entry points, to attract a broader number of people. Of those who have experienced a tech support scam, one in five continued with a potentially fraudulent interaction such as downloading software, visiting a scam website, giving scammers remote access to a device, or providing credit card or other payment information.



### SITE SEEING

## Trust In Internet At All-Time Low

The status quo isn't good enough anymore, and companies need to change their policies and procedures to reduce the number and impact of data breaches, according to a new report by the nonprofit Internet Society. This latest study, looking at data breaches from 2015, shows that the average cost of a data breach is now \$4 million, or \$158 per lost record, up 29% and 15%, respectively, since 2013. In 2015, there were 1,673 data breaches impacting 707 million exposed records. Of those, the Internet Society reports, 93% were preventable.

A record 59% of respondents to the society's 2016 Global Internet

Report survey said they would not do business with a company that had suffered a data breach. "This status-quo isn't good enough anymore. As more and more of our lives migrate online, the cost and risk of a data breach is greatly increased and will lead to lost revenues and a lack of trust," said report author Michael Kende.



The society offered several suggestions, including increasing transparency about the risk, incidence, and impact of data breaches; requiring companies to implement "best-practice standards" when it comes to data security; and holding organizations more accountable for breaches.

Johnson &amp; Johnson

## Job Of The Month

Johnson & Johnson is well known to consumers worldwide, as it is a corporate giant in medical devices, pharmaceuticals, and packaged goods. The company's HQ is in New Jersey, and it currently has an opening in its Raritan offices for an IT lead engineer - application development tools and automation. This position is responsible for creating and improving various software tools used by vendors, employees, and suppliers. Applicants must have a bachelor's (advanced degree preferred) in MIS or CompSci and at least five years experience in development. The more experienced you are with Agile and Waterfall, the better, and it helps if you're a scrum master. Linux and SQL ninja skills are hot ticket items, as is extensive work with DevOps tools such as Bitbucket/Stash/Git, Nexus, Puppet, Chef, and so on. Johnson & Johnson has been around for about 130 years, so if you're burned out on startups and want a more established work environment, here you go. You can grab more details at [www.jnj.com](http://www.jnj.com).

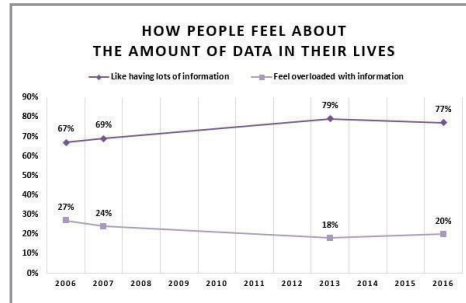
Source: Johnson & Johnson

## Excuse Me, I Really Need To Read This Text

A survey conducted periodically by Pew Research over the past decade shows that about one in five people in the U.S. now feel overwhelmed by the amount of information they have to deal with in their lives. This number has ticked up a couple of percentage points in the past few years, but it's still well below the number who felt that way

10 years ago. In 2006, Pew says more than 1 in 4 people were feeling anxious about so much data in their lives, a condition better known as "information overload." While the percentage of anxious folks has decreased in 10 years, the percentage who say they are just fine with the amount of information coming their way has increased, moving up from 67% in 2006 to 77% today. As a group, the majority of us seem to be adapting just fine to the daily deluge of emails/texts/tweets/posts/calendar notifications/voicemails/Snapchats/status updates/YouTube videos/meeting reminders/etc.

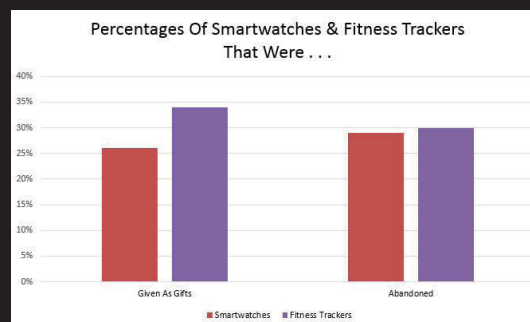
Source: Pew Research Center



## It's Either Time For A Workout, Or My Watch Is Broken

Smartwatches and fitness bands are two of the more recent digital products brought to market. They fall in the tech product category known as wearables. Gartner surveyed more than 9,500 people to learn what they think about both types of products. Analysts discovered that 10% of people have used a smartwatch, and nearly 19% have used a fitness band. Although most people buy smartwatches and fitness bands for themselves, more than one-fourth of smartwatches and one-third of fitness bands are given as gifts. The abandonment rate for both products is high, however, with 29% of the watches and 30% of the bands abandoned by users. Reasons for abandonment include boredom, people not finding them useful, and breakage.

Source: Gartner



## RAW Numbers:

### 15

The percentage of people who try out a virtual reality headset, enjoy the experience, and then purchase a VR headset. About 50% of people who try out VR enjoy the experience and plan to purchase a VR headset in the future.

Parks Associates

### 2,000

The average number of articles accessed on the online open-source encyclopedia Wikipedia.com every 0.3 to 0.4 seconds, which is about the same amount of time it takes to blink an eye.

Wikimedia Foundation

### 129,000

The number of petabytes of cellular data expected to be generated annually by smartphones, tablets, connected cars, and other mobile devices by 2018. This is about the same amount of information that would be transmitted if you streamed 14 billion hours of 4K video.

Juniper Research

### 6 million

The number of pairs of so-called "smart footwear" (shoes that include processors) expected to ship annually by the year 2021.

ABI Research

### 190 million

The number of mobile devices that made use of biometric recognition (including fingerprint, voice, and facial identification) during 2016. This number is expected to more than triple to 600 million in five years.

Juniper Research



# Look Out Below

## NCIX PC's Avalanche 001 Wins Intel's Extreme Rig Challenge

NCIX PC System Designer and R&D Coordinator Leadthaniel Le designed, coordinated, and built (along with Jimmy, NCIX's senior watercooling technician) the company's entry in the recent Intel Extreme Rig Challenge, a no-holds-barred contest among seven high-end PC manufacturers to create the most extreme rig possible with the newest Intel Extreme Edition processor. We talked with him recently about the experience of competing on that level, and about his contest-winning creation, the Avalanche 001 (pictured on this month's cover, right next to the Intel Extreme Rig Challenge trophy).

**Q: Can you talk about the parts you used in building the Avalanche 001 and how you chose them?**

**LL:** I figured most people would go with an SLI and PCIe SSD build, so I wanted to stand out in any way that I could. I picked LED RAM and I decided to watercool the SSD, as well, to add some extra flair. I was happy to find out that no one else had LED RAM or had attached a waterblock to the Intel 750 SSD, which I feel set the Avalanche apart from the crowd.

**Q: How were the system's CPU and GPUs clocked?**

**LL:** I got the CPU to a nice, even 4GHz and managed a 17 to 20% boost on the GPU clock, but GPU clock speeds never round out to a nice, even number for easy memorization.

**Q: How long did it take you to complete the build?**

**LL:** After waiting for parts, it took a solid month to put together. The mod work took up the most time. The loop plan was already in my head, but I had to make changes once it came time to build. No plan survives first contact.

**Q: Can someone go to the NCIX PC site and order an Avalanche just like the one that won the Challenge?**



**LL:** Of course they can. I've already sold a few already.

**Q: How much does it cost?**

**LL:** A cool \$10,000. You're not just buying a bunch of components, you're getting the expertise, attention to detail, and the knowledge to build a beautiful, powerful system.

**Q: We noticed in the pictures on your site that there's a graphic on the power supply that reads, "Avalanche 001/100" on it. Is this configuration a limited edition?**

**LL:** More of a limited run for the Avalanche. We're happy to work

with clients to customize the build to their liking.

**Q: This rig has a really interesting cooling system; are there two loops in there, or is it all one big loop?**

**LL:** It's all one big loop. After you design a few loops you start to repeat certain runs because they work, they are functional, and they are efficient. I decided on a few flourishes in the loop design to set the Avalanche apart. An efficient run would have felt sterile.

**Q: Have you benchmarked the system, and if so, can you share some numbers with us?**

Advertisement

**LL** : Oh yes, I benchmarked the system. You'll just have to buy one to see the scores yourself.

**Q** : In retrospect, is there anything you'd do differently with this build?

**LL** : Oh god yes. I'm never happy with a build. Even right to the end, I was tweaking the build and Francis was telling me, "Stop, we need to get this shipped." Full whiteout interior paint, one set of radiator fans that are GPU-regulated, sequential lighting upon system power up, nickel-plated tubing, the list goes on.

**Q** : What was the most challenging aspect of building Avalanche 001?

**LL** : Composition. Making sure the theme is drilled home in every aspect of the build. No odd and ends that don't seem to mesh.

**Q** : What's your favorite thing about this PC?

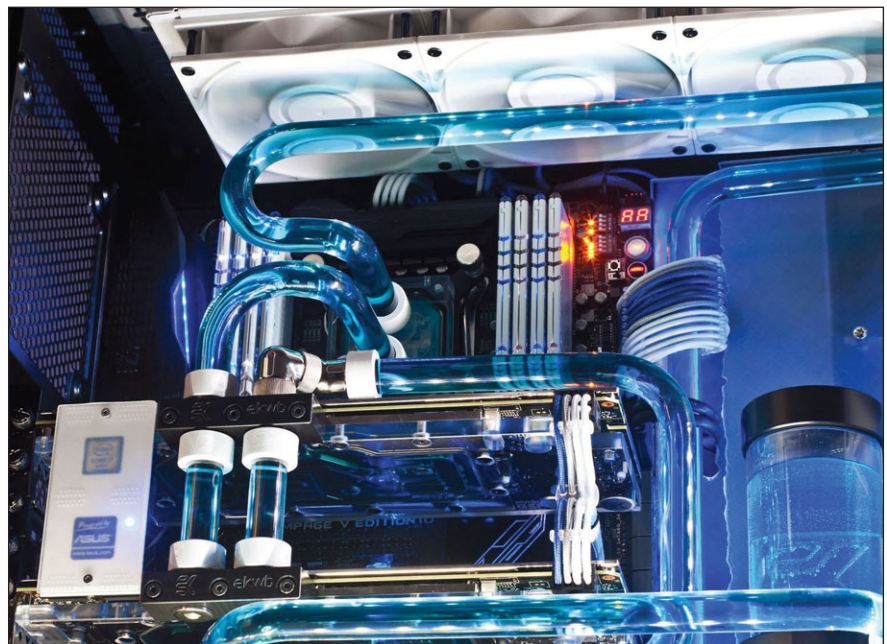
**LL** : I love the paint job on the case. It's hard to pick up in photos, but the case shimmers like snow.

**Q** : What was it like taking part in the Intel Extreme Rig Challenge?

**LL** : Stressful, fun, *stressful* . . . and *fun*. In that order.

**Q** : How did you feel when you found out that your rig had won the contest?

**LL** : The day the polls closed, I was pretty sure I was ahead but I was purposely avoiding looking at the standings so it wouldn't drain my energy. I wanted to stay upbeat and enjoy that I was still in the competition and not worry about whether I was winning. How did it feel? Amazing. It's great that the community liked my build. I would like to hear from people who didn't like the Avalanche. It's like how you can't proofread your own work. ■





"The AORUS brand is off to a good start with the GA-Z270X-Gaming 5."



## AORUS GA-Z270X-Gaming 5

Whether you're shopping for laundry detergent, ice cream, or a PC part, brand name is likely something that weighs into your decision. And while you probably spend more time researching a motherboard than a laundry detergent, it's easier to find high-end products if you know the brand in question specializes in quality. AORUS is a premium gaming brand of GIGABYTE, and up until today, AORUS has been mostly known for notebooks. The GA-Z270X-Gaming 5 is one of the first AORUS motherboards, and it also serves as our first look at the Z270 chipset.

GIGABYTE isn't going away as a motherboard brand, nor will its G1 Gaming series, we're told. The AORUS brand, similar to ASUS' ROG brand, is aimed at gamers and is where you'll find the most innovative, cutting-edge motherboard additions. The GA-Z270X-Gaming 5, for instance, provides some interesting new twists for onboard lighting and fan controls. Higher-end AORUS motherboards, such as the GA-Z270X-Gaming 7 or GA-Z270X-Gaming 9, also feature built-in support for liquid

cooling with blocks designed by EK Water Blocks or Bitspower.

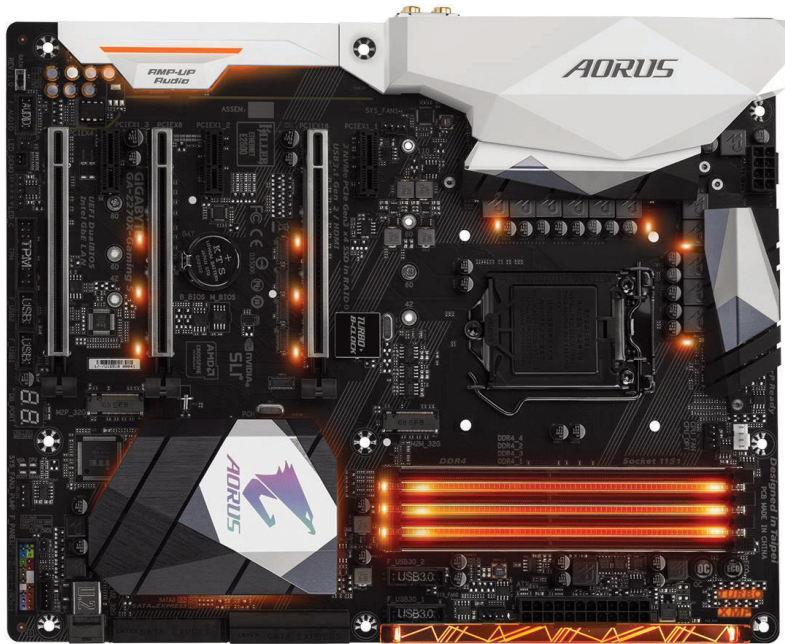
The RGB lighting on the GA-Z270X-Gaming 5 is dazzling. AORUS provides LEDs all around the board, and the illumination is customizable via the RGB Fusion utility. There are multiple lighting zones, each of which can have a different color and effect, including modes to pulse a single color, cycle through the entire 16.8 million color spectrum, and sync with music or PC conditions, such as CPU temperature. The GA-Z270X-Gaming 5 can also synchronize lighting with select GIGABYTE graphics cards and third-party light kits. For the latter, the GA-Z270X-Gaming 5 provides an RGBW light strip pin header to support a wider array of LED light kits.

The Z270 chipset is quite similar to the Z170 chipset. For right now, one of the notable differences is that Z270 provides four additional PCIe 3.0 chipset lanes (up from 20 in Z170 to 24 in Z270) for more port flexibility. The GA-Z270X-Gaming 5 takes advantage of the extra chipset lanes to deliver two M.2 ports (type 2242, 2260, 2280, 22110),

a U.2 port, two NICs (the Killer E2500 and Intel's i219V), two USB 3.1 ports, and three PCIe x1 slots.

Many Z170 motherboards feature similar or identical connectivity, but such a setup generally requires several ports to share bandwidth. For example, we've reviewed several Z170 motherboards where you could connect two M.2 drives and a U.2 drive, but doing so shuts off all of the SATA ports and the bottom PCIe x16 slot. The GA-Z270X-Gaming 5 allows you to fill up both of the two M.2 ports, the U.2 port, and four of the 6Gbps SATA ports, while only losing the bottom PCIe x16 slot.

The Z270 chipset also arrives alongside Intel's desktop Kaby Lake processors, and we tested the GA-Z270X-Gaming 5 with Intel's Core i7-7700K. Intel's Skylake processors, such as a Core i7-6700K, can also work on this board, or any other Z270 motherboard. The compatibility isn't a huge point in Z270's favor though, because many Z170 motherboards support desktop Kaby Lake chips via a firmware update. Another possible reason to jump to the Z270 chipset is



support for Intel's Optane technology. Although not yet available, SSDs with Intel Optane memory are anticipated to use Intel's XPoint technology to provide speedy storage.

Priced at \$194.99, the GA-Z270X-Gaming 5 falls on the lower spectrum of AORUS Z270 motherboards, yet it has almost all of the high-end performance capabilities of the more expensive boards. For example, you can install up to 64GB of DDR4-4000 memory, as well as a 3-way CrossFire or 2-way SLI graphics card configuration. The GA-Z270X-Gaming 5 also features Hybrid Fan pin headers that automatically detect the type of cooling device connected.

We tested the GA-Z270X-Gaming 5 using both Intel's Core i7-6700K and the Core i7-7700K. The benchmark results with the Core i7-6700K matched up with what we've seen from recently tested Z170 motherboards. Moving to a Core i7-7700K bumped up scores in processor-intensive tests

anywhere from 6 to 12.5%. The largest gains were seen in SiSoftware Sandra's 2016 tests, while improvements in Cinebench 15 and POV-Ray 3.7 were a modest 6.3% and 7%, respectively. Pairing the GA-Z270X-Gaming 5 with GIGABYTE's GeForce GTX 1080 Xtreme Gaming helped to produce healthy frame rates (all above 87fps) in our game tests.

The AORUS brand is off to a good start with the GA-Z270X-Gaming 5. Bright RGB lighting throughout the board makes it incredibly easy to customize the look of your PC, and device support is everything we've come to expect from a GIGABYTE motherboard. We look forward to seeing other AORUS motherboards this year. ■

BY NATHAN LAKE

**GA-Z270X-Gaming 5**

\$194.99

AORUS

[www.aorus.com](http://www.aorus.com)

#### Benchmark Results

Benchmark Results	AORUS GA-Z270X-Gaming 5
3DMark Fire Strike Extreme	10073
Graphics Score	11054
Physics Score	13418
PCMark 8	
Creative Score	5900
SiSoftware Sandra 2016	
Dhrystone AVX2 (GIPS)	206.44
Whetstone AVX (GFLOPS)	121.55
Multi-Media Integer AVX2 x32 (Mpixels/s)	582.86
Multi-Media Long-int AVX2 x16 (Mpixels/s)	214.08
Multi-Media Quad ALU x1 (Mpixels/s)	2.39
Floating B/F AVX/128 (GBps, mem bandwidth)	36
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	2388
Sequential Write (Q32T1)	1218
Random 4K Read (Q32T1)	720.1
Random 4K Write (Q32T1)	356
POV-Ray 3.7 (Pixels/s)	2021.78
Cinebench 15 (Points)	942
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF, SSAA off)	107.22fps
Dying Light (High, AO On, AA On, Vsync Off)	122.6fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	87.6fps

**Specs:** Max memory: 64GB DDR4 (DDR4-2133; Max OC: DDR4-4000); Slots: 3 PCIe 3.0 x16, 3 PCIe x1; Storage: 2 M.2 (type 2242, 2260, 2280, 22110), 1 U.2, 6 6Gbps SATA, 3 SATA Express; Rear I/O: 1 HDMI, 1 DisplayPort, 2 USB 3.1 (1 Type-C, 1 Type-A), 2 USB 3.0, 4 USB 2.0, 1 PS/2, 2 Ethernet (Killer E2500 and Intel i219-V), 1 S/PDIF, audio I/O; Form factor: ATX; Warranty: 3 years

**Test System Specs:** Intel Core i7-7700K; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 32GB DDR4-3200MHz; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise



"The drive performed exactly as advertised, galloping through sequential workloads and delivering solid random read/write performance, particularly at high queue depths."



## Toshiba OCZ VX500 512GB

Reports of 6Gbps SATA SSDs' death have been greatly exaggerated. If Mark Twain could've been a power user, we like to think he would've admonished his fellow enthusiasts (ourselves included) over the countless prematurely penned obituaries for solid-state drives that use the 6Gbps SATA bus. After all, SATA is old but not extinct. In fact, we'd say that the arrival of PCIe SSDs has been a benefit for 6Gbps SATA drives, too. Now, SATA SSDs are extremely affordable; you can buy a hilarious amount of solid-state storage with only a little scratch. And guess what? It turns out 6Gbps SATA SSDs are still pretty fast.

One terrific example is Toshiba's OCZ VX500 family of SSDs. They take the baton from OCZ's Vector 180 line; right away we noticed that the VX500 drives have received an external makeover. The metal housing looks terrific and has a slight shine to it; if aesthetics matter to you, don't

be afraid to put the VX500 on display. The drive's slim 7mm height makes it a solid choice for notebooks, as well.

Toshiba continues OCZ's practice of relying on in-house components for its SSDs. The VX500 relies on Toshiba's TC358790 storage controller, which has previously appeared in the company's Q Series Pro and HG6 SSDs. We're more excited about the presence of Toshiba MLC NAND. With so many manufacturers turning to TLC NAND as a means of cutting costs, it's nice to see OCZ stick with MLC in the VX500. As a result, all of the VX500 drives boast impressive endurance ratings. The 1TB VX500 leads the way, promising 592TB TBW. The 512GB VX500 we tested has, expectedly, a TBW rating of 296TB. It's no wonder OCZ offers a five-year warranty on these SSDs.

To test the 512GB VX500, we turned it loose on CrystalDiskMark and AS-SSD. The drive performed exactly as advertised, galloping through sequential workloads

Benchmark Results*	Toshiba OCZ VX500 512GB
<b>CrystalDiskMark 5.1.2</b>	
Sequential read	542.6
Sequential write	512.1
4K read	24.65
4K write	139.5
Sequential read (QD32)	552.9
Sequential write (QD32)	522.5
4K read (QD32)	381.8
4K write (QD32)	264.8
<b>AS-SSD 1.9.5986.35387</b>	
Sequential read	521.25
Sequential write	490.88
4K read	22.18
4K write	117.59
4K read (64Thrd)	359.74
4K write (64Thrd)	233.95
<b>*all results in MBps</b>	

and delivering solid random read/write performance, particularly at high queue depths. The VX500 proved to us that 6Gbps SATA SSDs aren't going away anytime soon. ■

BY VINCE COGLEY

### OCZ VX500 512GB

\$194.99

Toshiba

ocz.com

**Specs:** Interface: 6Gbps SATA; Controller: Toshiba TC358790; Maximum sequential read/write: 550MBps/515MBps; Random 4KiB read/write: 92,000 IOPS/65,000 IOPS; Form factor: 2.5-inch; Warranty: 5 years

**Test system specs:** Processor: Intel Core i7-7700K; Motherboard: AORUS Z270X Gaming 5; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 32GB DDR4-3200; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise



"For 20 bucks, the CHOPPER ADVANCE has plenty of power, and even more pizzazz."

## LEPA CHOPPER ADVANCE

Once upon a time, manufacturers could occasionally get away with one-dimensional wares. Make a product with unparalleled performance, and most enthusiasts would forgive you if it was ugly as a toad. Conversely, power users buying a particular component based on its looks might be willing to accept less-than-stellar performance.

We have a hard time believing that's the case anymore. As markets become increasingly crowded and cutthroat, a company's survival depends on doing everything well, because if you're not willing to invest in making hardware that performs as awesome as it looks, you'd better believe the next guy is. LEPA clearly understands this, and its new CHOPPER ADVANCE case fans provide the proof.

Clearly, LEPA put the fans' aesthetic front and center; they're made to dazzle, relying on a thin PCB strip with LEDs attached to the fan rotor to accomplish this mission. LEPA outfits the CHOPPER ADVANCE with either blue, red, green, or white LEDs. The white

model has a nearly all-white construction, while the other three options use a black frame with a "halo ring" (more on that in a moment) colored to match the LEDs. The CHOPPER ADVANCE fans offer 30 lighting modes. The LEDs on the white model we tested were plenty bright, and the effects were brilliant. Be aware, though, that the lighting modes are not user-selectable. Instead, the CHOPPER ADVANCE cycles through all 30 and then starts over. Some might like the constantly changing nature of the fans' LEDs, but we'd gladly pay a little more to have some control over the effects.

Although form is clearly important to LEPA, it's equally apparent that function matters, as well. The CHOPPER ADVANCE is billed as having a modular design, and that's no exaggeration. For starters, you can remove the fan rotor from the motor, which can make cleaning much easier. We needed a Herculean amount of force—so much that we were afraid of snapping the frame—to remove the rotor initially. Subsequent attempts required

considerably less pressure to remove the rotor. LEPA goes further, though, and lets you practically disassemble the fan entirely. Both the frame and the halo ring consist of two pieces, and separating all of them is simple work.

Speaking of work, the CHOPPER ADVANCE works hard for you. That halo ring we keep mentioning was designed to increase airflow by 30%, according to LEPA. As a PWM fan, the CHOPPER ADVANCE has a rotational speed range of 600 to 1,500rpm, good for a corresponding airflow range of 29.48 to 70.38cfm.

For 20 bucks, the CHOPPER ADVANCE has plenty of power, and even more pizzazz. If you want your system to stand out, it's a standout fan. ■

BY VINCE COGLEY

### CHOPPER ADVANCE

\$19.99

LEPA

lepatek.com

**Specs:** Dimensions: 120 x 120 x 25mm; Speed: 600 to 1,500rpm; Airflow: 29.48 to 70.38cfm; Air Pressure: 0.432 to 1.833 mm-H<sub>2</sub>O; Noise: 8 to 80dBA; Connector: 4-pin; Available colors: Blue, red, green, white



# RIDE THE LIGHTNING



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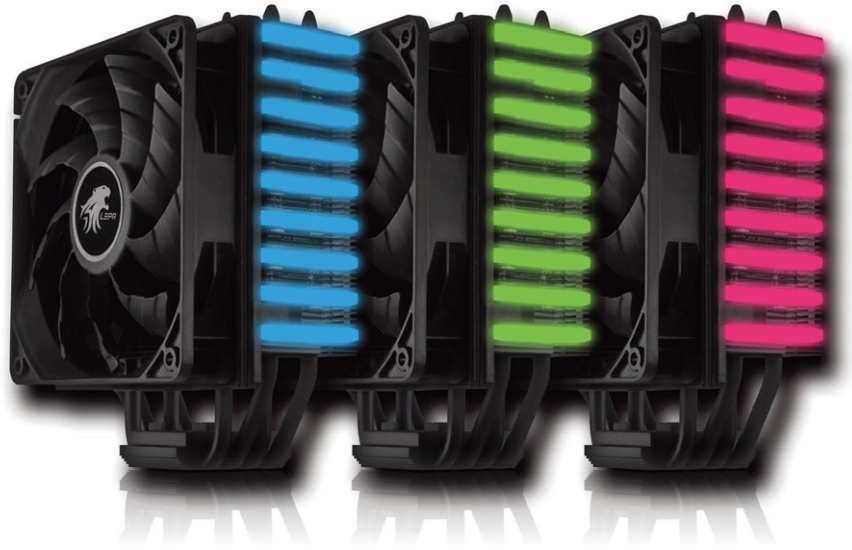
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## LEPA NEOllusion

RGB LEDs have forever changed the modding landscape. Where it was once time consuming to color match or compliment the parts of a system build, RGB LEDs built into fans and system components allow you to get creative with relative ease. CPU coolers, being one of the most visible parts of a system build, are an excellent candidate for RGB illumination. LEPA's new NEOllusion air cooler is outfitted with RGB LEDs on the top and bottom of the heatsink, as well as in the small LEPA logo on the top cover. LEPA even includes a remote that lets you select one of 16 colors and apply lighting effects.

Outside of the CPU cooler's RGB LEDs, the NEOllusion's design is quite similar to LEPA's LV12 air cooler. Both models feature four 6mm heatpipes that make direct contact with the processor, as well as a slim profile heatsink to avoid obstructing system memory. The NEOllusion also utilizes LEPA's S.N.T.C. (Super Nano Thermal Conductive), which is a coating that helps the heatsink to resist oxidation without

negatively affecting the heatsink's ability to efficiently move heat.

The NEOllusion includes one 120mm fan, and interestingly, the fan has no LEDs. LEPA tells us that, based on market research, the company found people would like to see LED lighting effects on different parts and components, rather than just the fan. The company is also working on different designs, though, and might include fan LED lighting effects in the future. In our opinion, RGB illumination from the fan might detract from the look of the NEOllusion. The LEDs on the top, bottom, and cover are plenty bright, as is, and more LEDs might make it garish. Points to LEPA for avoiding the "too much of a good thing" trap.

The 120mm provides a PWM range of 600rpm to 1,800rpm and will generate airflow between 29.33cfm and 75.41cfm. Noise levels peak at 33dB(A). If that's too loud for your build, you can install the included fan speed adapter and drop the fan's PWM range to between 400rpm and 1,000rpm, which in turn lowers noise levels to 19dB(A) or less.

Temperatures under load were comparable to what we've seen with other slim air coolers when paired with Intel's Core i7-6700K. In POV-Ray 3.7, the NEOllusion kept the Core i7-6700K to an average of 64.9 degrees Celsius with a maximum temp of 70 C. When pushing all threads with Prime95, average core temperatures raised to 78.7 C and a maximum of 82 C. Average Idle temperatures were a mere 26.3 C.

RGB or no, air coolers are no stranger to fans with LEDs. But by installing the RGB LEDs above and below the vertically oriented cooler, rather than in the fan on the side of the cooler, LEPA ensured the NEOllusion looks like no other air cooler – at least, none that we've seen. In our test system, we particularly like how it illuminates the black metal plate on the GIGABYTE GeForce GTX 1080 Xtreme Gaming. The RGB capabilities, of course, make it easy to coordinate the lighting and refine your build's color scheme. ■

BY NATHAN LAKE

**Specs:** Materials: Copper (base, heatpipes), aluminum (fins); Fan: 120mm PWM (600 - 1,800rpm); Cooler Dimensions: 6.37 x 2.56 x 4.96 inches (HxWxD); Socket compatibility: Intel LGA 775/115X/1366/2011(3), AMD AM2 (+)/AM3 (+)/FM1/FM2 (+); Warranty: 1 year





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"Where clarity, noise reduction, and other qualities desirable in a mic are concerned, the MM5 takes a long step past most mics included with gaming headsets and earbuds."

#### ModMic 5

\$69.95

Antlion Audio

[www.AntlionAudio.com](http://www.AntlionAudio.com)

## Antlion Audio ModMic 5

When we crossed paths with Antlion's ModMic 4 back in January 2016, we walked away considerably impressed. A year later, our enthusiasm only extends for Antlion's excellent new ModMic 5. That's primarily due to numerous user-requested enhancements Antlion made to ultimately craft a pricier (\$20 extra) but more versatile and durable model.

For the uninitiated, the ModMic is a detachable boom mic that uses a simple but effective magnetic system to attach to any headphones, including high-end, expensive cans you might already own or are eying but that lack a mic. By adding mic functionality, the ModMic saves you from having to buy a separate gaming headset or settle for the typically inferior audio quality gaming headsets produce compared to even quality midrange headphones.

So what constitutes the MM5's higher price? Not better mic quality actually, as even Antlion notes there's no difference over the MM4 here. The MM5, however,

does do with one unit what the MM4 needed four SKUs to accomplish. Namely, the MM5 integrates omnidirectional and unidirectional mics into one capsule, along with a switch to toggle them. Further, Antlion bundles a removable mute switch by default now. It sits between the boom mic's short cable and one of two extendable cables (1m and 2m lengths) Antlion includes, both with 3.5mm jacks.

Anyone who games in varying environments knows why inclusion of both mic types is enticing. While the omnidirectional setting (studio mode) outputs more realistic audio and is best for quieter settings (a cozy man cave, for example), the unidirectional mic (noise-reduction mode) reduces ambient noise to lessen the impact of a noisy setting (think a large LAN party) on communication.

The MM5 also includes stronger Kevlar-reinforced cabling, a beefier steel spine for the boom's flexible arm, cable wraps, and stronger magnets. Those magnets attach to clasps that connect the boom to headphones,

and setup couldn't be easier. Just attach the 3M adhesive-backed base clasp to the headphones and the top magnetic clasp on the boom arm to this. When finished, just separate the magnets. I used Superlux HD668B semi-open headphones, and the base magnet connected firmly to the earcup's mesh covering just as Antlion promised. (USB and Y adapters for Mac, console, and mobile device use are available from Antlion, as well.)

Where clarity, noise reduction, and other qualities desirable in a mic are concerned, the MM5 takes a long step past most mics included with gaming headsets and earbuds I've used in recent years. Recordings, chats, in-game communication, and calls were exceedingly clear and strong. In unidirectional mode, those I communicated with reported similar stellar results. Overall, we're not talking professional studio-level mic quality, but the MM5 isn't that far off. ■

BY BLAINE FLAMIG

**Specs:** Unidirectional capsule: Sensitivity,  $-38 \pm 3$  dB; Response, 100Hz to 10kHz; SNR:  $>50 +$  dB; Impedance, 2.2 ohms; Max input SPL, 110dB; Omnidirectional capsule: Sensitivity,  $-26 \pm 3$  dB; Response, 30Hz to 17.5kHz; SNR,  $58 +$  dB; Impedance, 2.2 ohms; Max input SPL, 110dB; Connector: 3.5mm plated TRS for PCs; Extras: carrying case, foam pop filter



"If you eventually want to liquid-cool your GPU . . . the Eisbaer 360 is ready-made for the job."



**Eisbaer 360**  
\$147.99  
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[www.alphacool.com](http://www.alphacool.com)

## Alphacool Eisbaer 360

The majority of AIO CPU liquid coolers are closed loops that have been factory filled and sealed, so you'll never need to perform maintenance. An AIO's preassembled design also makes it much easier to install than the disparate pieces of a custom water loop, but the factory seal prevents you from expanding the loop. The Alphacool Eisbaer 360 is a different breed of AIO liquid cooler. It has all the traditional benefits of a preassembled closed-loop kit, and Alphacool adds a quick disconnect fitting so you can expand the loop without having to drain the system or take it apart.

Alphacool provides a couple of ways to make the Eisbaer 360 work with other liquid-cooling parts. The quick disconnect built into the tubing is compatible with Alphacool's lineup of quick-release connectors, which smartly include adapters for standard G1/4 fittings. The Eisbaer's quick disconnect is also compatible with Alphacool's Eiswolf GPX-Pro AIO kits

featuring a GPU waterblock and radiator. The Eisbaer 360's pump and radiator feature standard G1/4 fittings, so you can add thicker hoses or hard tubing down the road if you want a truly custom look. Alphacool provides a fill port on top of the pump to easily refill or add coolant when expanding the loop.

Alphacool's background is primarily in custom liquid-cooling parts, and the company sells its own fittings, pumps, radiators, reservoirs, and waterblocks, among other cooling accessories. The Eisbaer 360 is a collection of Alphacool's top-end components. For instance, the 360mm radiator is based on Alphacool's NexXos ST30 360. The radiator's pure copper construction helps it outperform the aluminum radiators so common in closed-loop coolers. The built-in pump is similar in design to Alphacool's DC-LT Ceramic Ultra Low Noise pump. PWM control allows for pump power as low as 7V, for quiet

operation, and a maximum of 12V that delivers a pump speed of 2,600rpm.

To dissipate heat from the 360mm radiator, Alphacool provides three of its 120mm Eiswind fans that feature a high static pressure (up to 1.66mm/H2O). Similar to the pump, the 120mm fans are PWM controlled with a range of 550 to 1,700 rpm. Alphacool includes a three-way splitter so you can connect all three fans to a single fan header. The system was nearly silent during idle, but fan noise is definitely audible when all three fans are running at 1,700rpm.

Our testing results show that the Eisbaer 360 is well equipped to help you reach peak overlocks. After running Prime95's Small FFT torture test for 10 minutes, Intel's Core i7-6700K maxed out at only 76 degrees Celsius, while average temperatures during the test reached 72.1 C. We ran the same test on an Intel Core i7-7700K with average and maximum temperatures reaching 73.4 C and 78 C, respectively. We also ran POV-Ray 3.7 on both Intel chips for 10 minutes, with maximum temperatures hitting 64 C (Core i7-6700K) and 66 C (Core i7-7700K).

The ability to easily upgrade parts is one of the reasons we love PCs, and the Eisbaer 360 is much more flexible than a conventional AIO liquid cooler. If you eventually want to liquid-cool your GPU but aren't ready to upgrade right now or just want the option to expand the cooling loop down the line, the Eisbaer 360 is ready-made for the job. In the meantime, the Eisbaer 360's high-quality liquid-cooling components provide enthusiast-grade CPU cooling. ■

BY NATHAN LAKE

**Specs:** Materials: copper (waterblock and radiator); Socket compatibility: Intel LGA 2011(3)/2011/1366/115X/775/771/604, AMD FM2(+)/FM1/AM3(+)/AM2(+)/G34/C32; Pump: 2,600rpm, 7-13.5V; Fans: 3 120mm Alphacool Eiswind fans (550-1,700 rpm); Radiator dimensions: 1.18 x 15.63 x 4.88 inches (HxWxD); Warranty: 2 years

**Test System Specs:** Processor: Intel Core i7-7700K; Motherboard: AORUS GA-Z270X-Gaming 5; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 32GB DDR4-3,200MHz; Storage: 240GB Intel SSD 730 Series; OS: Windows 10 Enterprise



## Intel Core i7-7700K

A new year has just begun, and we finally have a new LGA1151 CPU from Intel primed to take on the mantle of best enthusiast processor this side of \$1,000. Although Intel gave us an early glimpse of Kaby Lake's mobile chops back in August, the Core i7-7700K is the desktop chip we've been waiting for. It's going to be a good year.

From a design and architecture standpoint, there's not a lot of revolutionary stuff under the IHS of the Core i7-7700K. It's a quad-core processor with Hyper-Threading enabled, letting it handle up to eight concurrent threads at a time. It has a 4.2GHz core clock, 200MHz faster than its Skylake counterpart, and a Turbo Boost 2.0 frequency of up to 4.5GHz, or 300MHz faster than the Core i7-6700K's limit.

These faster clocks and Kaby Lake's Speed Shift v2 technology, which lets it change clock speeds three times as quickly as Skylake, are the main attractions. But unless you've been living under a rock for the past year or so, you already know that this is still a 14nm process-based chip, the third 14nm processor family Intel has launched since Broadwell.

Say "goodbye" to Intel's Tick-Tock model and say "hello" to the PAO, (Process-Architecture-Optimization) release scheme. Kaby Lake is the optimization phase of this cycle, which means the process has evolved

slightly. Intel is calling it 14PLUS, and highlights of the tweaked process include a higher fin height and larger pitch, which give the transistors more breathing room, and as a result, Kaby Lake chips are seeing a 12% bump in performance due to the higher clocks. On the downside, because we're not getting a process shrink, this chip has the same TDP as the Skylake family's flagship Core i7-6700K, 91 watts.

Other features include 8MB of Intel Smart Cache, an 8GTps DMI 3.0 link between the processor and the Intel Platform Controller Hub, a dual-channel memory controller with a peak bandwidth of 38.4GBps, and support for up to 16 PCIe 3.0 lanes (and access to another 24 from the chipset).

This is, of course, a K Series processor equipped with an unlocked multiplier. Paired with a Z270 motherboard (or a compatible BIOS-updated Z170 motherboard), you can nudge the processor's operating frequency ever higher for even better performance. We managed to overclock the Core i7-7700K to 5GHz using an aftermarket air cooler, which means you should be able to do better with liquid or something more exotic.

The on-die graphics engine has also received a number of tweaks for Kaby Lake. The Intel HD Graphics 630 has a dynamic clock of up to 1,150MHz, and the revamped media engine features hardware acceleration for 4K VP9 and HEVC 10-bit encoding and decoding. This processor supports Netflix 4K UHD content and is capable of multi-streaming HD and Ultra HD video content.

The performance gap between Skylake and Kaby Lake is rather narrow, but if you're still running a 22nm processor or older, this chip should be on the top of your upgrade wish list. ■

BY ANDREW LEIBMAN

Core i7-7700K

\$339

Intel | [www.intel.com](http://www.intel.com)

"... as a result, Kaby Lake chips are seeing a 12% bump in performance due to the higher clocks."

Benchmark Results	Intel Core i7-7700K
<b>3DMark Fire Strike Ext.</b>	10,073
Graphics Score	11,054
Physics Score	13,418
Graphics Test 1	58.46fps
Graphics Test 2	40.8fps
Physics Test	42.6fps
Combined Test	22.98fps
<b>PCMark 8 Creative Score</b>	5,900
<b>Sandra 2016 Lite</b>	
Dhrystone Integer Native AVX2 (GIPS)	206.44
Whetstone Single-float Native AVX (GFLOPS)	121.55
x32 Multi-Media Integer AVX2 (Mpixels per second)	582.86
x16 Multi-Media Long-int AVX2 (Mpixels per second)	214.08
x1 Multi-Media Quad ALU (Mpixels per second)	2.39
x16 Multi-Media Single-float FMA (Mpixels per second)	506.27
Integer Memory Bandwidth B/F AVX/128 (GBps)	35.93
Float Memory Bandwidth B/F AVX/128 (GBps)	36
<b>Cinebench 15 (Points)</b>	942
<b>POV-Ray 3.7 (Pxps)</b>	2,021.78
Metro: Last Light (16xAF; SSAO off)	107.22fps
Dying Light (High, AO On, AA On, Vsync Off)	122.6fps
The Witcher 3 (Vsync off, Unl.fps, Ultra)	87.6fps

**Specs:** Clock speed: 4.2GHz (base), 4.5GHz (Turbo); 4 cores; unlocked multiplier; dual-channel DDR4 memory; 8MB Intel Smart Cache; Hyper-Threading; Turbo Boost; 14nm; 91W TDP

**Test system specs:** Processor: Intel Core i7-7700K; Motherboard: AORUS GA-Z270X-Gaming 5; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 32GB DDR4-3200MHz; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise



"It's hard to clear the bar that GIGABYTE has set with this card."



### GeForce GTX 1050 G1 Gaming 2G

\$139

GIGABYTE

[www.gigabyte.us](http://www.gigabyte.us)

## GIGABYTE GeForce GTX 1050 G1 Gaming 2G

Reports of the death of the entry-level graphics card have been greatly exaggerated. It's true, AMD and Intel have made gaming without a discrete graphics card a slightly less embarrassing endeavor, but the GIGABYTE GTX 1050 shows that there's still a wide performance gulf between it and the fastest Intel HD Graphics inside Sky Lake processors and AMD APU-based GCN gen three R7 graphics. For less than \$150, it's hard to clear the bar that GIGABYTE has set with this card.

The GTX 1050 G1 Gaming 2G we tested features a fairly compact design. Although it is still a two-slot card, it measures 8-inches from the bracket to the edge of the black and orange plastic heatsink shroud. There's an aluminum backplate anodized black with orange painted accents. This card sports a WINDFORCE 2X cooler, which consists of a pair of 90mm fans positioned above an aluminum fin and copper heatpipe heatsink. The bulk of the heatsink is centered over the GPU and the 2GB worth of memory, with the two composite heatpipes converging over the top of the GPU to maximize heat dissipation. These heatpipes are multilayered, with a sintered copper inner core that allows a phase-transitioning liquid to circulate and rapidly move heat away from the hottest parts of the pipes. A smaller section of the heatsink also makes contact with the VRM.

The top edge of the card features an RGB LED backlit GIGABYTE logo and Fan Stop indicator. You can customize the colors and effects of these lights using the

XTREME Engine Utility, and you have 16.8 million colors to choose from.

The card is the highest-clocked version of the GTX 1050 available from GIGABYTE, and even the GTX 1050 Ti doesn't get such impressive clocks, although the latter card's 128 more CUDA Cores and larger frame buffer more than make up the difference. The reference design of the GTX 1050 is saddled with a 1,354MHz base and 1,455MHz boost clock, but GIGABYTE used its GPU Gauntlet Sorting methodology to find chips capable of running reliably with a 1,442MHz base clock and 1,556MHz boost clock. As with all of our recent GIGABYTE graphics card reviews, we are reporting the OC Mode numbers, which you can unlock using the firm's XTREME Engine Utility.

Who says overclocking can't come cheap in 2016 (and 2017)? GIGABYTE equipped this card with a 4 + 1 phase VRM, that's an extra phase compared to the reference design, which will let you push this card even harder to eke out a few more frames per second in modern games. High quality metal chokes and solid state capacitors, as well as a 2-ounce copper PCB all help ensure this card performs reliably for a long time.

As you can see from the benchmark scores, the GTX 1080 G1 Gaming 2GD feels right at home at 1,920 X 1,080, but it even manages to post playable framerates at 1440p. Take another look at the price on this thing. Yeah, we're impressed. ■

BY ANDREW LEIBMAN

### GIGABYTE GeForce GTX 1050 G1 Gaming 2G

Price	\$139
Core clock (OC Mode)	1,442MHz
Boost clock (OC Mode)	1,556MHz
Memory clock	7,008MHz
Memory interface	128-bit
Memory	2GB GDDR5
<b>3DMark Pro Fire Strike</b>	6,612
Graphics Score	7,109
Physics Score	24,768
Graphics Test 1	32.99fps
Graphics Test 2	29.08fps
Physics Test	78.63fps
Combined Test	11.72fps
<b>Games</b>	<b>1,920 x 1,080</b>
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	44.66fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	51fps
Dying Light (High, AO On, AA On, Vsync Off)	65.67fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	40.68fps
	<b>2,560 x 1,440</b>
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	29.77fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	30.33fps
Dying Light (High, AO On, AA On, Vsync Off)	41.9fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	27.33fps

**Test System Specs:** Processor: Intel Core i7-6950X; Motherboard: GIGABYTE GA-X99-Ultra Gaming; Memory: 16GB HyperX Predator DDR4-3000; Storage: 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise



"... Aerocool is one of the best companies around at delivering cool aesthetics and the latest design features at affordable prices."

## Aerocool LS-5200

The latest case to arrive from Aerocool HQ is the LS-5200, a black steel and plastic mid-tower with an acrylic left side-panel window and a roomy interior designed to accommodate a full-blown liquid-cooling system. The "LS" in "LS-5200" stands for "Liquid Solution," so it's little surprise going in that the case will accept installation of either a 280mm or 360mm radiator behind the front panel and either a 240mm or 280mm radiator beneath the top panel. Additionally, the front and top panels consist largely of black steel mesh, and each is equipped with a thin foam dust filter.

The upshot of all this is that you can pack a lot of high-end PC gear inside this case and easily keep it all very cool. Toward that end, Aerocool built in two fan control switches at the top of the front panel and also

includes a steel power supply shroud, which savvy builders know serves two purposes: It creates a separate cooling zone for the PSU, and it helps keep the inside of your case looking nice and tidy.

Atop the PSU shroud, you'll find two 2.5-inch drive mounting trays that you can remove with a thumbscrew when it's time to install SSDs or hard drives; there's also a dual-bay 3.5-inch drive cage located behind the power supply shroud toward the front end. Add all of those to the two vertical 2.5-inch drive mounts attached to the back of the motherboard tray, and you can load this case up with as many as six drives.

The LS-5200's motherboard tray accepts microATX, Mini-ITX, and ATX boards, and the case will hold graphics cards up to 13.6 inches long with fans installed behind the front

panel (14.6 inches without). Full-sized power supplies and CPU air coolers are of course no problem, so there are very few if any limits on what kind of system you can build inside.

The outside of the case has a simple yet angular style that makes it a nice fit for a gaming rig or just about any kind of build; Aerocool gives it a few design notes that remind us of the excellent P7-C1, yet it rings in at just \$89.99, proving once again that Aerocool is one of the best companies around at delivering cool aesthetics and the latest design features at affordable prices. ■

BY CHRIS TRUMBLE

**LS-5200**

**\$89.99**

Aerocool

[www.aerocool.us](http://www.aerocool.us)

**Specs:** Dimensions: 20.8 x 8.6 x 16.5 inches (HxWxD); Materials: Steel, plastic; Motherboard support: Mini-ITX, mATX, ATX; Drive bays: 2 3.5-inch/2 2.5-inch internal, 4 x 2.5-inch internal; Fans (included): 1 x 120mm rear; Fans (optional): 3 x 120mm/2 x 140mm front, 2 x 120mm/2 x 140mm top; Ports: 1 x USB 3.0, 2 x USB 2.0, audio I/O



# CPU's Best Of 2016

## We Select Our Favorite Products From The Year In 13 Categories

We review a great many PC tech products throughout the course of a year, and sometimes as we move on to the next product, and the next one, and the next one, it's easy to forget how great some of them really were. So this holiday season, the staff here at *CPU* decided to take a moment as one year slips away and another arrives to recognize some of the cool stuff we had come through our offices in 2016. We chose our favorite products from each of 13 categories; below you'll find out what they were and why we chose them, as well as a couple products from each category that we thought merited Honorable Mention recognition.

### Best Case: Fractal Design Define C

We've been fans of Fractal Design's Define-series cases for several years; as

a general rule, they look great, they're easy to work with, and they come with all of the latest case design innovations, often well before you'll see those things in other stock case offerings. They are also incredibly well made, and best of all, they all ring up at right around \$100 or less.

The Define C retails for less than \$90 and improves on the amazing Define S in a couple significant ways: It's a hair smaller, while still accommodating a similar complement of hardware, and it comes with a power supply shroud that makes it even easier to keep the interior of your system squared away. We saw quite a few great cases in 2016, but at the end of the day, it's hard to beat the Define C for quality, utility, and value. ([www.fractal-design.com](http://www.fractal-design.com))



**Honorable Mentions:** CaseLabs Bullet BH4, Deepcool Gamer Storm Genome

### Best CPU: Intel Core i7-6950X

If early indications are accurate, 2017 may be a much more competitive year in the field of desktop CPUs than 2016 was, but there were still some pretty cool processor launches in the year we just left behind. The biggest, baddest CPU on the block—by a huge margin—was the



flagship of Intel's Broadwell-E family of chips, the Core i7-6950X.

The 6950X is a 10-core, 20-thread beast with a stock clock speed of 3GHz, but Intel's Turbo Boost 3.0 technology can crank that up to 3.5GHz as needed, and Turbo Boost Max can pick specific cores based on perf needs and jack them up even higher, all the way to 4GHz.

This 14nm marvel packs 3.2 billion Tri-Gate transistors and 24MB of on-die Intel Smart Cache; it also has a TDP of 140 watts, which is pretty impressive, all things considered. The chip provides 40 PCIe lanes, and supports quad-channel DDR4 memory via the X99 chipset—up to a staggering 128GB of it. Benchmarks told the tale: The Core i7-6950X was far and away the highest-performing CPU released in 2016, and that gets it the nod in our list of favorites. ([www.intel.com](http://www.intel.com))

**Honorable Mentions:** AMD Athlon X4 845, Intel Core i5-6600K

### Best CPU Cooler: Cooler Master MasterLiquid Pro 240

All-in-one liquid CPU coolers are largely the default choice for DIY builders who aren't quite ready to commit to the complexity and expense of a custom cooling system, and the MasterLiquid Pro 240 from Cooler Master stood head and shoulders above similarly priced competitors in 2016. According to the manufacturer, the MasterLiquid Pro 240 has a dramatically redesigned waterblock with 657% more surface area, which



equals more effective heat dissipation, as well as a radiator that uses square aluminum cooling fins that maximize contact with the liquid channels.

Here's what really made up our minds, though: In our tests, a Core i7-6950X cooled by the MasterLiquid Pro 240 never got hotter than 48.23 degrees Celsius, and that's the temp we got while running Prime95's small FFTs torture test; POV-Ray 3.7's max CPU test only raised the mercury to 43 C. Lots of products make claims about superior cooling, but this one delivers, and we have the numbers to prove it. Cooler Master gave it an MSRP of \$119.99, which is right in line with the market, too, so we gave it the *CPU Cutting Edge* Award for innovative design. ([www.coolermaster.com](http://www.coolermaster.com))

**Honorable Mentions:** EK-XLC Predator 360, be quiet! Pure Rock Slim

### Best Desktop PC: AVADirect Avalanche Mini

Put simply, the Avalanche Mini is a microATX Death Star. Of course, like

the lowest of which was a 57fps in *The Witcher 3* with settings turned way up. It's ready and willing to game at 4K, and it's VR-ready, as well.

But the Avalanche Mini doesn't just run games at silky smooth frame rates without the slightest hitch; it also looks like a showpiece. The immaculate interior is lit by a soft LED glow that shows off its custom hard tube cooling loop (you pick the color via remote control), and the Corsair Carbide Series Air 240 (in white, of course) is a great showcase for all that hardware. And we can't forget that the Mini comes with AVA's Silver Warranty Package, a three-year limited parts and labor warranty that includes lifetime tech support. Game, set, and match. ([www.avadirect.com](http://www.avadirect.com))

**Honorable Mentions:** Altex AION Ares, MSI Trident



most AVADirect PCs, you can order it in a variety of configurations, but our review unit was packing an Intel Core i7-6700K (overclocked to 4.8GHz), ASUS' Z170-DELUXE mobo, and an EVGA GeForce GTX TITAN X, and it produced amazing benchmark results,

### Best Graphics Card: SAPPHIRE NITRO+ Radeon RX 480 8GB

There were a ton of great new graphics cards this year, and although it's not the fastest or even the most innovative, we love the NITRO+ 480 for pushing the price/performance





envelope. SAPPHIRE's Dual-X custom cooling solution combines with its NITRO Boost overclock to push AMD's Polaris GPU with its GCN architecture from its stock core speed 1,120MHz (1,266MHz Boost mode) all the way up to 1,342MHz with the flip of a switch on the top of the card—this will be the easiest overclock you've ever done.

The NITRO+ also serves up RGB LED lighting, VR compatibility, and high-end 1440p gaming, all for a wallet-friendly MSRP of just \$269. ([www.sapphiretech.com](http://www.sapphiretech.com))

**Honorable Mentions:** MSI GeForce GTX 1080 GAMING X 8G, EVGA GeForce GTX 1070 FTW GAMING ACX 3.0

### Best Headset: Arctic P533 Racing Gaming Headset

As most new gaming headsets are seemingly becoming bigger, bulkier, flashier, and more expensive, this headset's simplistic but cool retro and authentic racing design helped it stick out from the crowd. Its price is affordable, and its performance was right on par with other midlevel headsets we tested throughout the year. ([www.arctic.ac](http://www.arctic.ac))

**Honorable Mentions:** Patriot Viper V360, Creative Labs SoundBlaster X Pro Gaming H5



### Best Keyboard: Cooler Master MasterKeys Pro L

We reviewed the MasterKeys Pro S, which is the same keyboard but without the numpad the Pro L has in the customary position to the right of its main key array. We loved it, but we prefer the full-sized version; we are big fans of the numpad. We approve of the MasterKeys Pro boards' minimalist design, bright LEDs, and on-the-fly macros. We also like the way you can cycle through LED backlight modes using the FN key.

Elsewhere, this keyboard supports both N-key and 6-key rollover, and comes equipped with Cherry MX switches (Red, Blue, or Brown). Our review unit had Red switches (no



tactile "bump," no click), and it proved itself a worthy gaming keyboard. ([www.coolermaster.com](http://www.coolermaster.com))

**Honorable Mentions:** Patriot Viper V760, AZIO MGK L80 RGB

### Best Laptop PC: MSI GE72VR APACHE PRO

Our review from October says it all: "Notebooks with GeForce GTX 10 Series cards are now the ultimate power in the mobile gaming universe." This 17.3-inch beauty is equipped with a GTX 1060 with 1,280 CUDA cores and 6GB of 8,000MHz GDDR5 memory, and it is ready and willing to run the latest games at blistering frame rates given the GE72VR's 1,920 x 1,080 native resolution. And speaking of the display panel beneath this notebook's lid, MSI builds in an IPS screen and its proprietary True Color Technology, which gives you easy access to preset viewing modes.

The GE72VR produced some very playable frame rates at 1080p, including 60fps in Metro: Last Light and in



Dying Light, and 39fps in The Witcher 3. All that and it weighs less than six pounds and comes with SteelSeries' excellent Engine 3 LED-backlit keyboard. Game on! ([us.msi.com](http://us.msi.com))

**Honorable Mentions:** XOTIC PC MSI GT72VR Dominator Pro-015, EUROCOM Sky DLX7

### Best Memory: Corsair Vengeance LED 32GB DDR4-3200MHz

Corsair is an old hand at making fast, dependable memory, and its



latest DDR4 lines are no exception. High clock speed, low latency, and of course it doesn't hurt that the Vengeance LED kit we chose as our favorite for 2016 looks amazing to boot; the LED bars on top of these DIMMs "breathe" when your system is powered up. The effect is very cool, especially when paired with a motherboard that's also equipped with red LEDs. ([www.corsair.com](http://www.corsair.com))

**Honorable Mentions:** AVEXIR Red Tesla 16GB DDR4-2666, Patriot Viper Elite Series DDR4 16GB 3200MHz

### Best Motherboard: GIGABYTE GA-X99-Ultra Gaming

In 2016, the X99 chipset and Broadwell-E processors ruled the performance landscape in the high-end PC world, and GIGABYTE's GA-X99-Ultra Gaming board is the finest blend of features, performance, aesthetics, and value that you'll find on the market. Connectivity options include M.2, U.2, SATA Express, and USB 3.1 Type-C, among others. Its eight DIMM slots support up to 128GB of quad-channel DDR4 memory, and its Ultra Durable construction and other power management features make it a capable overclocker.

Want to run SLI? CrossFire? No problem, the X99-Ultra Gaming is ready and waiting. It performed admirably in our testing, has a great-looking red and white color scheme and customizable LED lighting, and it rings up at \$280, which is a pretty good price for a board of this caliber. ([www.gigabyte.us](http://www.gigabyte.us))

**Honorable Mentions:** MSI X99A TOMAHAWK, GIGABYTE GA-Z170X-SOC FORCE





**Best Mouse: Patriot Viper V560**

There's a lot to love about the Viper V560 laser gaming mouse, from its performance to its comfort and aesthetics, but most of all it shows that there's still room for new players willing to innovate in the crowded peripherals market.



The rubberized black matte finish is comfortable to grip, even over extended periods of time, and the adjustable weight system lets you fine-tune the mouse to a weight and balance that best fits your play style. Additionally, we found it to be precise and easy to use at a variety of DPI settings, and it costs less than \$50. ([www.patriotmemory.com](http://www.patriotmemory.com))

**Honorable Mentions:** Logitech G501 Proteus Spectrum, Bloody TL80 Terminator Laser Gaming Mouse

**Best Power Supply Unit: ENERMAX Platimax D.F. 500W**

Yes, we know that lots of DIY guys enjoy the big kilowatt-plus PSUs, and who can blame them? Those things are great, and if you are running X99, an Intel Extreme Edition CPU, and multiple GPUs, it's better to have a little too much power than not quite enough. But ENERMAX has a real hit with the D.F. 500W, which uses the company's DFR (Dust Free Rotation) tech to keep

fan blades clean and everything running smoothly. It has ENERMAX's rock-solid power regulation, it's fully modular, and—drumroll please—it comes with individually sleeved cables right out of the box, not to mention cable combs to keep them looking tidy.



Oh, and lest we forget, the Platimax D.F. 500W has 80 PLUS Platinum certification and an MSRP of \$139.99,

which we consider a bargain for everything you get. ([enermaxusa.com](http://enermaxusa.com))

**Honorable Mentions:** FirePower Technology Firestorm 1050W, GIGABYTE XP1200M

**Best SSDs: Patriot Hellfire 480GB**

With the Hellfire PCIe SSD, Patriot roars back into the enthusiast SSD game. Toshiba 15nm NAND and a Phison PS5007 controller combine with all of the features you'd expect (TRIM support, advanced garbage collection, static and dynamic wear levelling, bad block management, and S.M.A.R.T.) to produce a really fast SSD in what has quickly become our hands-down favorite SSD form factor. M.2 drives are great because they are easy to install, take up very little space, and don't require a connection to your power supply. If you haven't tried one of these PCIe NVMe marvels yet, you owe it to yourself to take one—maybe this one—for a spin.

This drive produced some of the best benchmark scores we've seen to date and is reasonably priced for its capacity and performance. ([www.patriotmemory.com](http://www.patriotmemory.com))

**Honorable Mentions:** Toshiba OCZ RD400A 256GB, SanDisk Extreme 500 240GB ■



# State-Of-The-Art Standards

## Heat-Assisted Magnetic Recording



HAMR technology is based on existing hard drive technology with a hot new twist.

Hard drives don't get much love these days. Spinning-platter technology lives in the slow lane, and continuous improvements to NAND-based storage make it unlikely enthusiasts will use HDDs where performance is critical. But just because HDDs are slow doesn't mean they are irrelevant. For pure mass storage, such as space-hogging personal image and video collections, it's currently tough to beat the price-to-capacity of modern HDDs. We found that many 6TB and 8TB drives, for example, come in under 4 cents per

gigabyte. By comparison, even bottom-barrel SATA SSDs generally cost around 40 cents per gigabyte.

HDD manufacturers are looking for ways to improve data storage density to keep pace with the incredible jumps in SSD technology. HAMR (heat-assisted magnetic recording) is one of the long-awaited breakthroughs that would enable HDD makers to dramatically increase drive capacity, but there are numerous technical issues that have held it back. As HDDs reach the limits of current

magnetic recording technology, there's a real need for HAMR to succeed.

### Worn Out Tools

Modern HDDs are built using PMR (Perpendicular Magnetic Recording) or SMR (Shingled Magnetic Recording).

PMR was commercially introduced in 2005 and has been the dominant technology for data recording on HDDs ever since. Before PMR, HDDs used longitudinal magnetic recording where each data bit was aligned horizontally and parallel to the



spinning platter. PMR stands data bit regions on end in a hard disk's magnetic recording layer. The adjacent bits of PMR attract, instead of repel as in a longitudinal media, which helps to create more thermally stable magnetic bits. But after a decade at the top, HDD makers are beginning to reach the limits of what PMR can achieve.

Some of today's highest-capacity HDDs use SMR (Shingled Magnetic Recording), which allows for more narrow tracks to be written than PMR technology. SMR increases areal density by letting tracks overlap each other, like the shingles on a roof. When new data is written, the track is trimmed to create the shingled pattern. All the data can be read off of the trimmed section, so there aren't compromises to reliability.

There's a downside to SMR technology, though, because the drives aren't typically as fast as PMR HDDs. When data in a SMR HDD must be re-written, SMR must write the requested data, as well as the surrounding tracks. SMR technology groups the shingled tracks into bands, so the entire drive wouldn't need to be rewritten. Impressively, SMR has helped HDD makers to reach 10TB of capacity in a single 3.5-inch drive.

Based on these methods, it's challenging for HDD makers to evolve areal density, or the number of bits that can be stored on a given surface area, beyond 1.5Tbpsi (terabits per square inch). Hard drive manufacturers have already reached the 1Tbpsi barrier with 2.5-inch drives. "It is very difficult to increase the recording density of present hard disk drives since the flying height is as small as it can be made, the track density is near its maximum, and so is the linear density," says Frank Talke, professor, mechanical aerospace engineering, at the Center For Memory And Recording Research.

Data stability is a big reason why current PMR and SMR technology won't work at tighter densities. At some point, the bits and magnetic grains become so tiny that, under the influence of temperature, magnetized bits can destabilize, resulting in file corruption. This scientific phenomenon is known as the superparamagnetic effect, and it's one of the reasons that HDD makers moved

away from longitudinal magnetic recording (to PMR) more than 10 years ago.

### HAMR Brings The Heat

HAMR overcomes the superparamagnetic effect by using more resistant recording media and heating it during the writing process. Coercivity, which is the resistance of material to magnetic change, drops when media is heated to the Curie point (the temperature where a material loses its permanent magnetic properties). "The bit cell in HAMR can be made smaller since the recording media in HAMR has higher coercivity than PMR media," says Talke. "This allows smaller bits and, therefore, higher density."

A special laser on the HDD's write head brings a bit's magnetic grains close to, or beyond (depending on the design) the Curie point, and then the head applies the new magnetic field. The bit's magnetic direction will "freeze" as the grains cool down. The whole process of heating, magnetizing, and cooling the magnetic bits can take place at the same speed as current HDD technology.

If you think the HAMR process sounds like it's hard to achieve, you'd be

right. "Try to take a lubricant, heat it up in a very short time to more than 600 degrees Celsius, and cool it down in a few nano-seconds, and you see why you have a problem with the lubricant," says Talke. "The same can be said for the magnetic coating, the head material, the laser path, the materials in the transducer, etc."

HAMR would likely also need to work in coordination with current HDD technologies, such as PMR or SMR, to further improve storage density. Therefore, it's regrettable that the dense design of current HDDs can further complicate the use of HAMR. "The present PMR technology is already difficult since you have a head/disk interface at 1nm," says Talke. "Add PMR to the high and transient temperatures of HAMR, due to laser heating the material, and you see why HAMR is a very difficult technology."

HAMR hard drives will require some advanced heads that can apply both heat and a magnetic field one bit at a time. A near-field optical transducer is typically used to focus the laser beam onto the recording media. Researchers



HDD manufacturers are reaching the density limits of current HDD recording methods.



Inside a HAMR-based HDD, the recording media will feature a higher coercivity than media designed for perpendicular magnetic recording.

have been investigating the effect of HAMR on various materials for years, as there are several optical and thermal tradeoffs researchers have to consider. For example, HAMR must balance the head's laser power with the write current, which leads to compromises with read/write performance and reliability. Gold is one of the common head materials for near-field transducers, because gold offers good optical quality and chemical inertness.

For all the changes that HAMR makes to the writing process, reading HAMR-recorded data works no differently than with current hard drive tech. The HDD's head moves over the magnetic fields on the platter and can detect the polarity of the magnetic particles. Data is stored in an orderly pattern and the HDD will move the head to the exact location of needed files when your PC requests them.

### A Longer History Than You Might Guess

If you've read this far, you can see that the engineering challenges of HAMR are immense. Maybe more troublesome

is that HAMR technology have been in development for a long time. Back in 2001, the U.S. National Institute of Standards and Technology awarded a research grant worth more than \$21

million over a five-year period to a joint venture project featuring Seagate and many other research centers, including Carnegie Mellon University and the National Storage Industry Consortium.



HAMR technology could help data centers to increase server capacity without increasing the rack footprint.

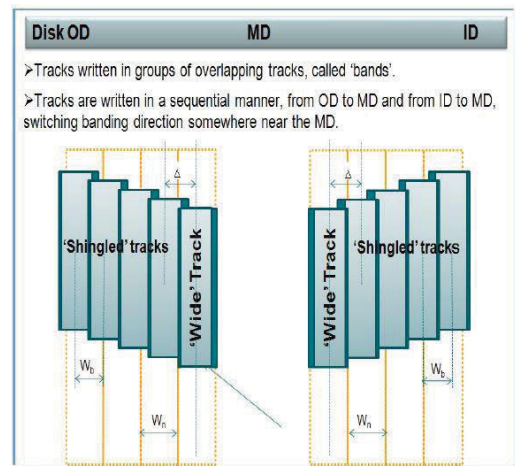


At various times in the last 10 years, HDD companies have shown off demos of HAMR-based HDDs, which have further fueled the belief that huge-capacity hard drives are right around the corner. In 2013, for example, Seagate showed off HAMR technology at CEATEC, while WD demonstrated HAMR technology at the 2013 China International Forum on Advanced Materials and Commercialization. The

meet on the Stanford campus for the 27th Magnetic Recording Conference. HAMR technology was a popular topic and there were several presentations about specific HAMR optimizations and fixes. Just some of the discussions included high track pitch capabilities for HAMR recording, areal density impacts of transition curvature, thermal gradient measurements, and optimizing the optical and thermal design.

44 zettabytes (a zettabyte is a trillion gigabytes) of data by 2020, up from less than 10 zettabytes in 2015. And by 2025, IDC believes the digital universe could be as large as 180 zettabytes. The Internet of Things and connected devices are expected to be a huge contributor to the digital universe. For instance, IDC expects the number of connected devices to jump from 20 billion today to 30 billion in 2020 and 80 billion in 2025.

## Shingled Magnetic Recording



Shingled Magnetic Recording is one of the current HDD technologies used to improve areal density. With SMR, new tracks overlap part of a previously written track. (Image courtesy of Seagate)

demonstrations over the years show that researchers have been able to create drives that function, though it's anyone's guess as to how reliable they were.

The HDD industry has continually pushed back dates for when consumers can expect to see HAMR technology in hard drives. "HAMR drives have been predicted to come out very shortly for at least four or five years," says Talke. "It has not yet happened because the technology is very difficult."

The current outlook on HAMR isn't all doom and gloom. Last August, a group of researchers and HDD experts

We asked both Seagate and WD if they had any plans to release HAMR drives in the near future. Seagate told us that they remain on track to ship in volume in 2018. WD said they were also committed to making HAMR HDDs.

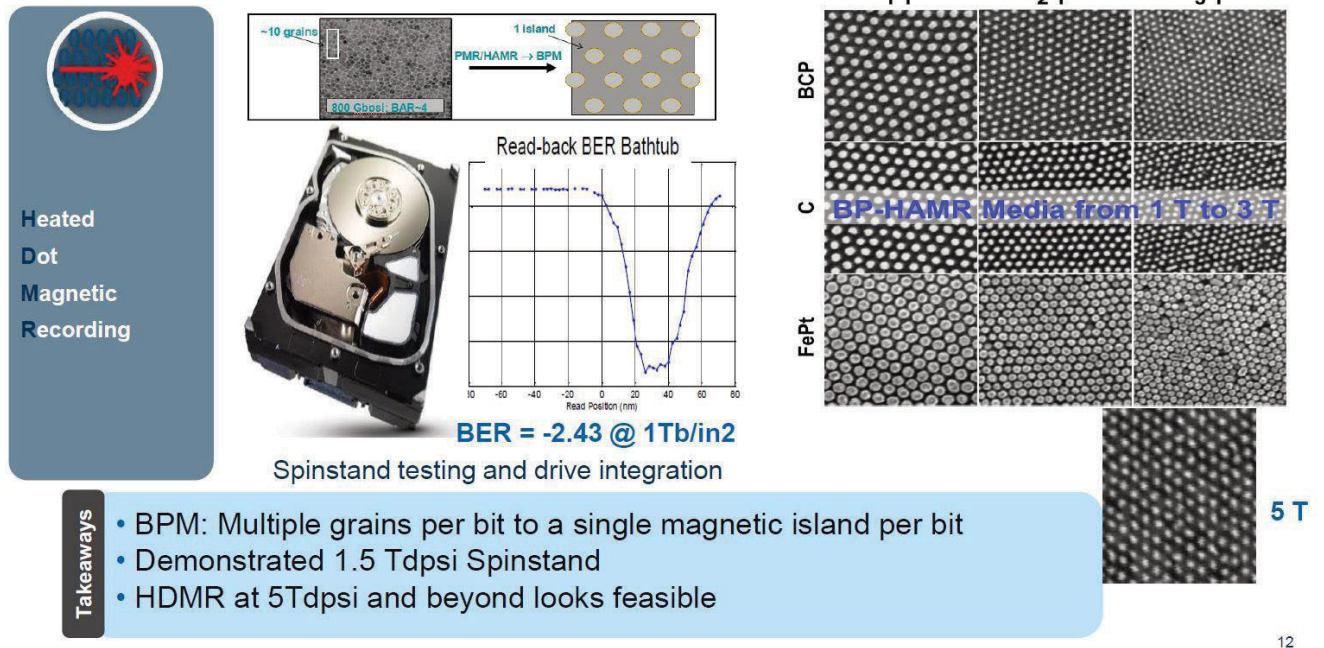
### Why HAMR Development Is Critical

Demand for storage is being driven by huge potential increases in digital data creation. Market research firm IDC (International Data Corporation) estimates that the digital universe, which is defined by the data we create, will be

It's not just machines that are generating more data. A recent report from Deloitte predicates that 2.5 trillion photos will be shared or stored online in 2016, and all of those photos, as well as videos and other personal file collections need to be stored somewhere. Increasing media quality, such as 4K video and 20MP images, also take up much more storage space than older multimedia. Digital data generated from business isn't slowing down, either. Metadata from emails and contacts, video surveillance, and file size increases

## Heated Dot Magnetic Recording= BPM + HAMR

Continuous FePt film patterned @ 1Tdpsi to 5Tdpsi



12

In the future, HAMR technology might be used with bit-patterned media for Heated Dot Magnetic Recording. (Image courtesy of Seagate)

further add to the need for high-capacity storage.

SSDs will continue to work alongside the HDD in enterprises and data centers to help organizations meet the demand, but the cost of SSDs will likely remain a barrier to adoption, unless NAND or SSD makers can find a way to lower prices. If HAMR or another HDD technology were to make its way onto the market, storage organizations might be able to more cost-effectively scale with storage demands.

Sure, data centers could just increase the number of servers—or put more drives in a storage system—but floor space in a data center is extremely valuable. Data centers also have to consider how additional servers would affect a server room's power and cooling. Higher-capacity HDDs might allow a data center or enterprise to increase capacity without the need to also increase server footprint or renovating the server floor for additional power and cooling. Consider that a 60-drive server with 8TB HDDs would offer just under

a half petabyte of storage capacity, while the same server with 20TB HDDs could provide 1.2 petabytes.

### HAMR To HDMR

Should HDD manufacturers succeed with HAMR technology, HDMR (Heated Dot Magnetic Recording) is the next reasonable step to improve hard drive areal density. It's been theorized that HDMR could produce areal density beyond 10Tbpsi. HDMR progresses beyond HAMR by using BPM (bit-patterned media) to create a row of uniformly spaced magnetic bits set inside a non-magnetic material. The bits are sometimes referred to as islands, and the isolated design helps to improve the magnetic and thermal stability of each bit.

BPM allows for much denser bits than existing HDD technologies. Using BPM, nanolithography technology patterns bits into magnetic islands as small as 5nm. Similar to HAMR, HDMR uses a laser to heat each island beyond the Curie temperature.

HDMR isn't expected to appear on HDDs in the near future. In a 2015 Seagate forecast, for example, the company projects 2025 for initial HDMR product integration.

### HDD vs. SSD

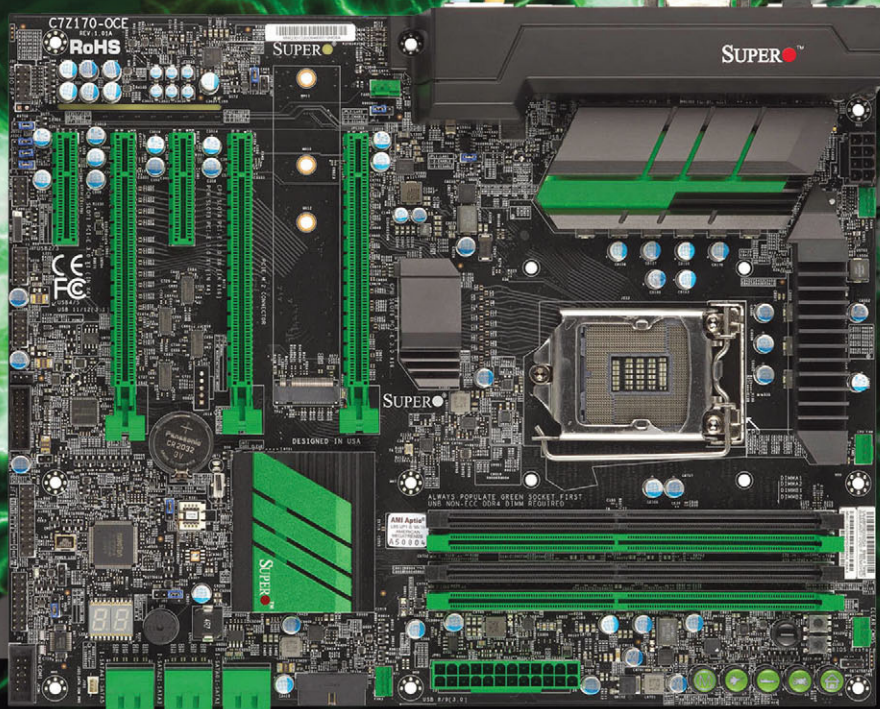
HAMR technology looks to be the best path to success for HDDs. Talke says, "The potential of HAMR is great and it would be wonderful if the technical issues could be solved soon." Of course, HDDs are no longer the only way to pack a single drive with high-capacity storage. In August, Seagate demoed a 60TB SSD designed for enterprises, and if released, the SSD would be four times the storage capacity of the next highest-capacity SSD available. If SSD makers—which now include the HDD giants WD and Seagate—find a way to cost-efficiently produce SSDs anywhere near 60TB capacities, the magnetic spinning platter might fall into disuse. HAMR, it seems, may be the only way forward for HDDs. ■



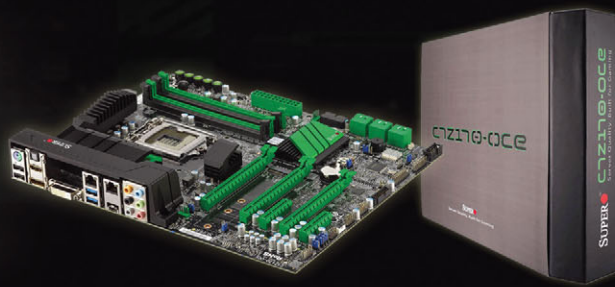
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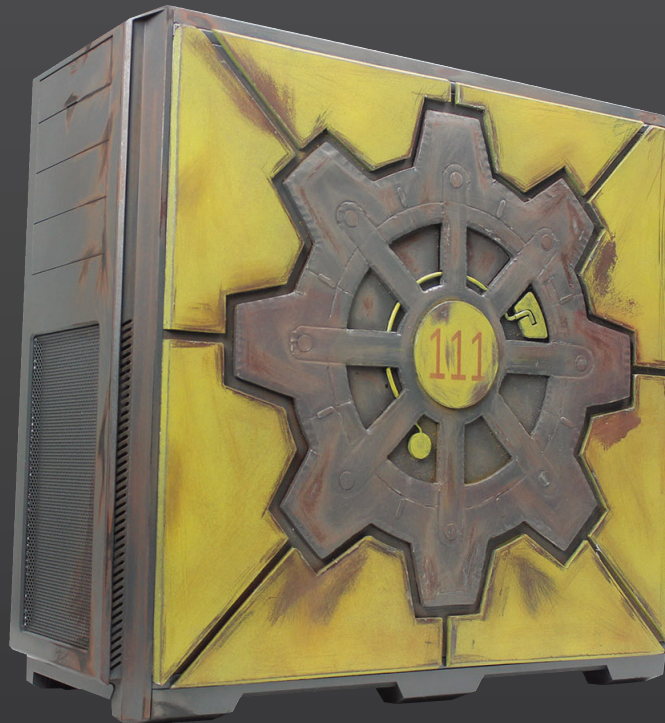
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# Fallout Vault 111 Decontamination Pod

**M**ost modders and fans of modding in general don't require an introduction to this month's Mad Reader Mod winner, Dewayne "Americanfreak" Carel, CEO and editor-in-chief of Modders-Inc, so we'll just get right to his latest MRM-winning creation: Fallout Vault 111 Decontamination Pod. With a name this descriptive, it's not hard to figure out where Carel's inspiration came from; if you haven't been living in a cave the past year, you know that Vault 111 is the starting point for Fallout 4, one of the biggest videogame releases of 2015.

"When doing a theme mod, I look throughout the game, movie, or whatever the theme is taken from and I find a few things that I believe will grab your attention and that can be molded into the shape of the case," Carel says. "If you pick something that is normally round and you try to make it fit a box shape, well, it is just not going to look good."

No problem here; despite the fact that the big, rolling vault doors themselves are round, this mod's namesake, the Decontamination Pod doors are rectangular, and both sides of this mod turned out great regardless of shape.

Carel says he built this Fallout mod for NVIDIA, who intended to give it away as part of a contest.

"This system was built for someone to enjoy it and show it off because of their love for the Fallout series," Carel says. "My goal was to produce a clean, recognizable piece that could travel and be easily maintained when it got to its new home. EVGA also had a special-edition graphics card that they were releasing for the new game; I think I might have been one of the first people to see and use this special card."

## Turning A Case Into A Vault/Pod

"I figured that the creation of this mod was going to be heavier on the aesthetics than on the modding of the case," Carel says. "The only real mod that I did to the case was cutting the side panel for the decontamination pod window. This had to match the look that was in the game to make it recognizable."

As you can see, it's very recognizable. We half expected to see a person sleeping inside.

Of course, Carel's modesty neglects to point out that he also constructed a super-cool replica of Vault 111's outer vault door on the opposite side from the decontamination pod door. Carel says he spent about 40 to 50 hours altogether on this project. He used 1/8-inch-thick foam





board to create the texture and the various levels on his side panel vault door.

"I had a vision in my head of how I wanted this mod to look, and I was able to achieve that 100%," he says. "This rarely happens, as there is always something along the way that you have to change to make it fit or it just didn't come out right. So when it works out this way, I bask a little in the glow of my accomplishment."

### Open The Vault

The Fallout Vault 111 Decontamination Pod does a decent job of keeping its components from being contaminated; they include an Intel Core i5-6600K, an ASUS Z170-A motherboard, 16GB of HyperX Fury DDR4-2133 memory, an EVGA GeForce GTX 970 Fallout Edition graphics card (check out the fly Vault Boy art on the backplate!), a Corsair AX860 power supply, and an Intel SSD 535 Series 240GB drive. Carel started the project with a Phanteks Enthoo Pro case, and cools the rig with Swiftech's H220 X2 all-in-one liquid CPU cooler.

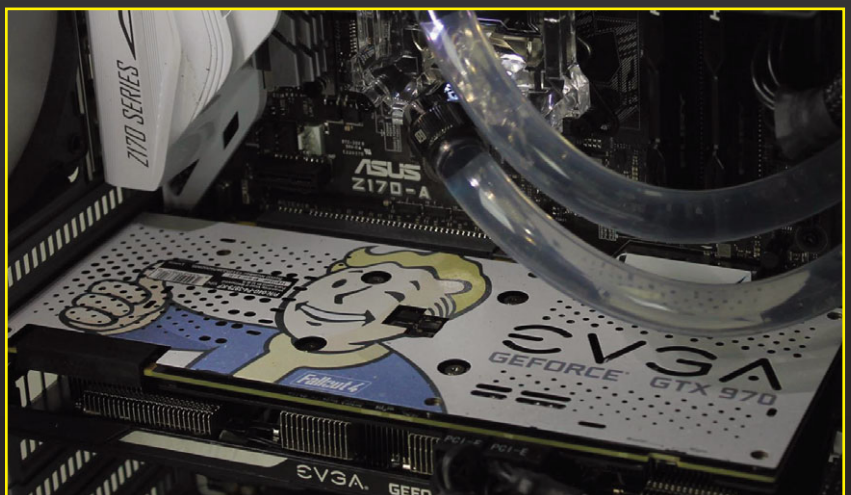
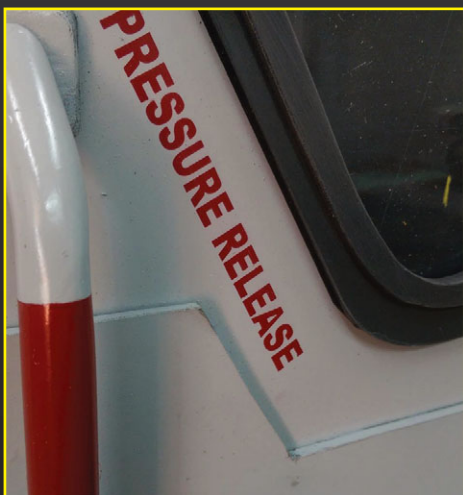
Carel mysteriously tells us that he has "one mod that I pull out and work on every once in a while," but declined to give more information. That's his only current project, though, because he and the rest of the Modders-Inc staff have been very busy of late hosting and running GIGABYTE's 30th Anniversary Mod Challenge. (You can check out the top three entries in this contest elsewhere in this very issue!) ■

## We Want Your Mod

Have a computer mod that will bring tears to our eyes? Email photos and a description to [madreadermad@cpumag.com](mailto:madreadermad@cpumag.com). If we choose your system as our "Mad Reader Mod," you'll win \$1,500! (U.S. residents only, please.)

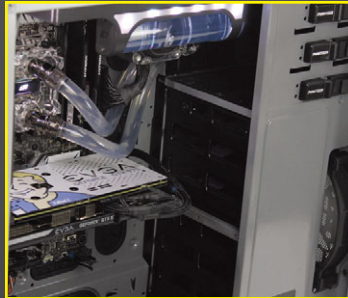


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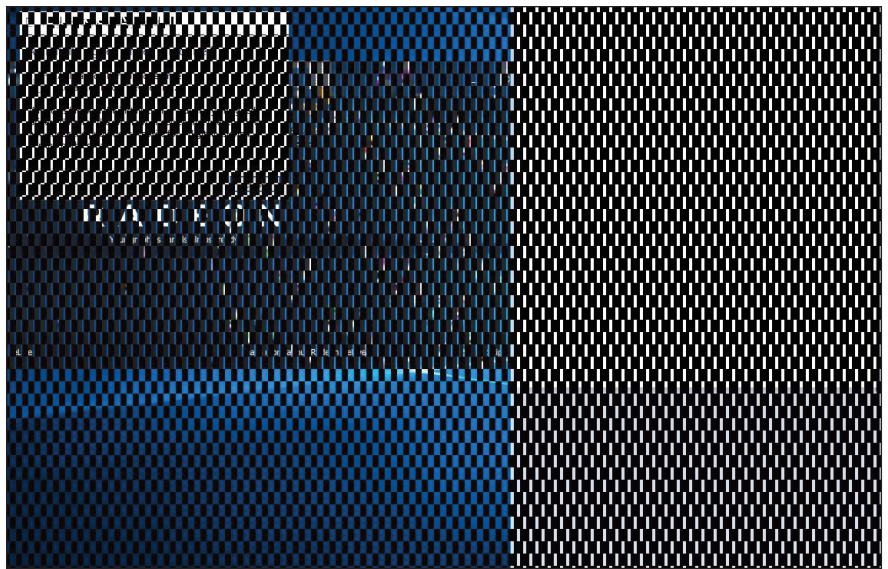
# A GPU That Punches Above Its Weight

## How To BIOS Mod Your Radeon RX 460

No, the Radeon RX 460 is not considered an enthusiast-class graphics card, but that doesn't mean there isn't a significant number of enthusiasts smitten by low-power, sub-\$150 graphics cards that target 1080p. And when you tell us that we can get 5 to 10% more performance by unlocking the card's dormant 128 stream processors with a simple BIOS mod? Well, then you have our undivided attention.

We decided to put this tweak to the test using the two Radeon RX 460s we have on hand: the SAPPHIRE NITRO model equipped with 4GB of memory and the XFX RX 460 with a Double Dissipation cooler and a 2GB frame buffer. The BIOS mod we're going to be using was first documented by German overclocker der8auer at [overclocking.guide](http://overclocking.guide). He, with the help of a few other forum users, developed a rather simple guide and posted downloads that include everything we need. We'll be following those procedures with some added information based on our own experiences.

At press time, supported cards include the ASUS RX 460 Dual OC 2GB, ASUS ROG STRIX Radeon RX 460 4GB OC Edition, GIGABYTE RX 460 Windforce 4G and 2G, HIS RX 460 iCooler OC 2GB, MSI RX 460 2GB OC, PowerColor RX 460 Red Dragon 4GB and 2GB, SAPPHIRE RX 460 2GB Dual Fan, SAPPHIRE RX 460 2GB, SAPPHIRE NITRO RX 460 4GB, XFX RX 460 Single Fan 2GB, XFX RX 460 Passive 4GB, and XFX RX 460 Double Dissipation 4GB. If you own or are thinking of buying one of these cards, chances are good you are in for some extra oomph.



You'll encounter the "screen door" bug if you're running the wrong graphics driver.

### Modder Beware

A note of warning before you begin. Although the procedure is rather simple, replacing the BIOS on your graphics card is no small matter. If something goes wrong, there are a number of things that can occur. Most often, graphics cards that don't support the hack will appear to run normally, but without the extra 128 stream processors unlocked. In this case, there's not much else you can do and you'll be forced to flash your old BIOS back to the card from the backup (we'll show you how to do this).

It's possible your graphics card will fail to output a visible image following a reboot. If this is the case, you may get lucky by booting the system with an integrated graphics adapter set as the primary device and using the



SAPPHIRE's NITRO RX 460 took to the modded BIOS like a duck to water.

ATIFLASH utility to install the backup BIOS to the faulty card. There's also a chance, however, that something

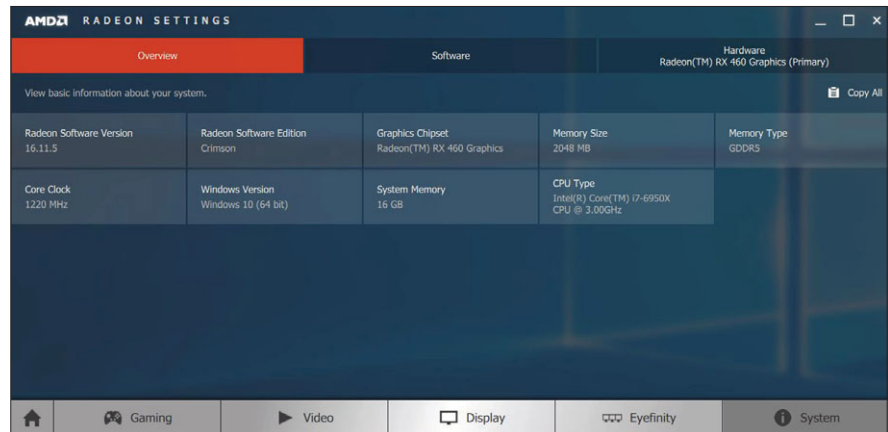
goes very wrong, and the BIOS flash renders your card unrecognizable to the system. Warranties don't cover these sorts of shenanigans, and if you do manage to irreparably brick your card as a result of BIOS flashing, don't expect to be able to RMA your way out of that hole. Although the chances of this happening are slim, you need to be aware it can happen.

Consider also that a manufacturer may have a good reason for disabling parts of the hardware. The 128 disabled SPs on your RX 460 may be damaged or prone to errors. Additionally, graphics cards tend to have rather strict thermal and power limits, and every Radeon RX 460 on the shelf today was designed and tested to perform optimally with 896 stream processors, not 1,024. If the unlocking is successful, there will be some additional power and heat demands put on your card. Consider yourself warned.

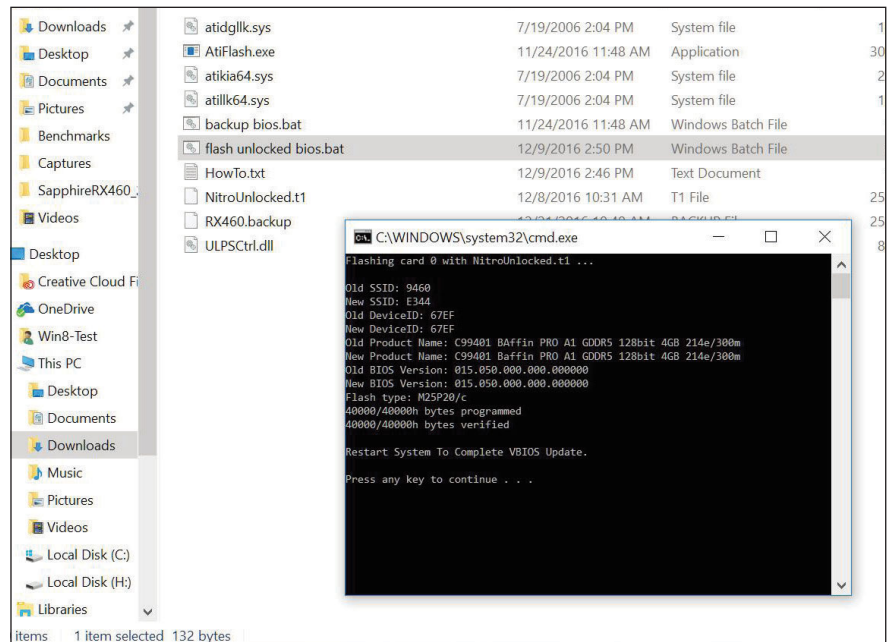
### Don't Overclock, Unlock

For those undeterred by the possible risks, the unlocking process is actually very simple, and the benefits are similar to a healthy overclock, but with less added heat and fan noise. All you need to do is flash a modded BIOS onto your Radeon RX 460 graphics card, restart your system, and then you're off to the races, or FPSes, or whatever it is you happen to play.

Although the unlocking process is easy to wrap your head around, the driver situation isn't as straightforward. If you attempt to flash one of the modded BIOSes when running the latest version of AMD's Crimson ReLive drivers (as we went to press, version 16.11.5), you will run into problems. This is because the modded BIOSes fail the signature check, which results in what's called a "screen door" error, so called because it blacks out the screen in a checkerboard pattern that makes it extremely difficult to see what's on-screen. There is a workaround that lets you bypass the signature check and run the Crimson ReLive driver, but for the sake of simplicity, we're going to start



Although it's less than ideal to have to run an old driver, it's at least a fairly recent driver.



All it takes to mod the BIOS is to double-click Flash unlocked bios.bat.

by installing a slightly older driver that won't offer up as many roadblocks.

To download Radeon Software Crimson Edition version 16.11.5 (from Nov. 25, 2016), visit [bit.ly/2g0D0On](http://bit.ly/2g0D0On) and click the installation package hyperlink appropriate for your OS. We tested this procedure on Windows 10 64-bit. Once the driver is downloaded, install it normally and reboot the system as instructed.

Before you proceed, make sure you have GPU-Z installed ([www.techpowerup](http://www.techpowerup)

[.com/gpuz](http://com/gpuz)). We will use this utility to create a backup of our Radeon RX 460's stock BIOS and to check the stream processor count to verify if the modded BIOS worked. Once it's installed, launch the utility, click the Save BIOS arrow icon just below the AMD Radeon logo, and then click Save To File. We recommend putting this in a safe place and naming it something you'll quickly recognize.

Once complete, visit the Overclocking Guide article at [bit.ly/2hTunqm](http://bit.ly/2hTunqm), scroll



SAPPHIRE NITRO Radeon RX 460	Stock BIOS	Modded BIOS	% Increase
Stream Processors	896	1,024	14.29%
<b>3DMark Pro Fire Strike</b>	<b>5,454</b>	<b>5,741</b>	<b>5.26%</b>
Graphics Score	5,849	6,209	6.15%
Physics Score	23,873	24,653	3.27%
Graphics Test 1	27.42fps	29.68fps	8.24%
Graphics Test 2	23.72fps	24.76fps	4.38%
Physics Test	75.79fps	78.27fps	3.27%
Combined Test	9.53fps	9.83fps	3.15%
<b>Games</b>	<b>1,920 x 1,080</b>		
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	36.89fps	39fps	5.72%
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	38fps	40fps	5.26%
Dying Light (High, AO On, AA On, Vsync Off)	50.98fps	52.48fps	2.94%
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	32.39fps	35.27fps	8.89%
	<b>2,560 x 1,440</b>		
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	25.1fps	26.43fps	5.30%
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	23.67fps	24.67fps	4.22%
Dying Light (High, AO On, AA On, Vsync Off)	31.39fps	34.31fps	9.30%
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	23.12fps	23.75fps	2.72%

to the AMD Radeon RX 460 Unlocking List, and then find your card. If you're in the market for one of these unlockable cards, some entries have a convenient Amazon.com hyperlink you can use to buy one. Next, click the hyperlink in the BIOS Download column and click the link on the next page to download the zipped package. Using WinZip, WinRAR, or your preferred file compression utility, extract the file folder. Inside it you'll find nine items, but you really only need to concern yourself with a few of them.

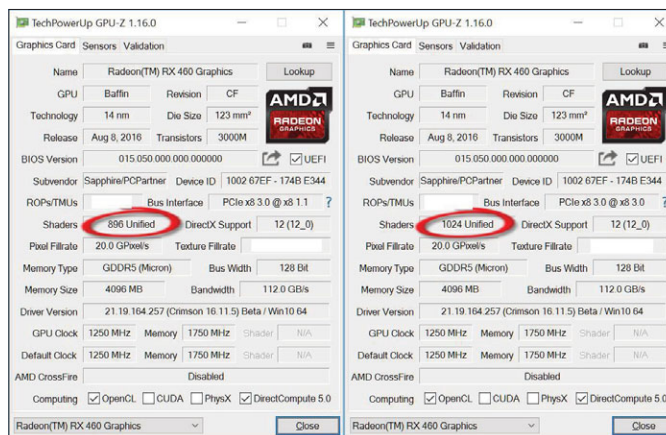
First double-click Backup bios.bat to create a copy of the RX 460's stock BIOS. Yes, we already created a backup with

any key to continue. Press a key and restart the system.

After the system is back up and running, launch GPU-Z and look at the Shaders box. A successfully unlocked RX 460 will display 1,024 Unified here. This was the result for us when we used the NITRO RX 460 4GB BIOS from the Overclocking.Guide article in conjunction with the corresponding graphics card.

### Not Everyone's A Winner

Astute readers will have noticed that the XFX RX 460 2GB with the Double Dissipation cooler is not listed as a supported unlockable card, but



In the above screen shot, the left side shows what our SAPPHIRE card looked like before the modded BIOS, and the modded BIOS version is on the right.

GPU-Z, but it never hurts to have more than one. The script will launch the Command Prompt and use the AtiFlash.exe utility to create the file. Next, double-click Flash unlocked bios.bat to run the unlocking command. The Command Prompt windows will complete the process in less than a minute, and then inform you to restart the system and press

that didn't stop us from trying. First we tried with most of the BIOSes that were designed to support 2GB cards. Although none of them managed to unlock the extra shaders, they were easy to recover from. Because there was no display corruption, we merely dragged the modded BIOS out of the folder, renamed the backup BIOS we created before flashing using the name of the modded BIOS, then just double-clicked Flash unlocked bios.bat. After a quick restart, our old stock BIOS was in place and the card was running fine.

We ran into real trouble when we abandoned our better judgment by installing the 4GB BIOS that worked so well with the SAPPHIRE card. The result was a corrupted display and forced restarts. Things went from bad to worse when we tried to flash the backup BIOS during one of the short-lived periods where the Desktop was visible, but the system crashed during the flashing process, and now the card doesn't output a display at all. We may be able to recover the card yet, but as we went to press, it was well and truly bricked.

In our experience, the procedure works as described as long as you own one of the cards for which a modded BIOS exists. If a modded BIOS doesn't exist for your card, we'd recommend checking the Overclocking.Guide article regularly for updates. ■

## And Then There Were Three

# The Top Mods In GIGABYTE's 30th Anniversary Mod2Win Challenge

Last month, we talked to GIGABYTE's Jonathan Lin in our monthly Back Door Q&A about his company's big 30th anniversary mod contest and found out that the winner would be chosen shortly after our interview. Naturally, we wanted to see how things turned out, so we asked Lin to share the results with us for our January issue, and here we are.

"This was an awesome mod challenge! We had a great turnout, and all the mod submissions were exceptionally built," Lin says. "Seeing how each mod came to life from a concept sketch to a completed masterpiece was a real treat. Now that it's over and we're heading into CES, my team and I are very excited to finally see the top three mods in person and showcase them for the world to see. We hope that you've all enjoyed this mod challenge as much as we have."

### First Place: Project Triptych (by boloisbolo)

"I initially started with the concept in June," says Lionel Del Fierro, aka boloisbolo. "When I first heard about the competition, I immediately went out and bought a GIGABYTE 980 Ti WINDFORCE to be one of stars of the build. However, shortly after having it in my possession, I had to postpone all work toward the build because of the birth of my son. I got back to work in September, beginning with the design of the custom case; this process was spread sporadically over a month until I sent it off to be manufactured. When the case finally arrived, I was ready to start building and finalizing the watercooling loop. The tubing took a couple days to complete, then I had to remove all the components and rebuild the system because it had to be put together in a certain order. The journey spanned intermittently over six months and ended in a flurry. I think the custom power button is my favorite part of the build. I know it is just a simple mod, with a small push button switch, wire, and some solder, but it seems to suit the design well. I forgot about putting a power button anywhere on the build until it was 90% complete. I didn't want to drill any other holes or have time to order a vandal-resistant switch, so I had the idea to just hide a small power button in an easily accessible spot inside the case. It worked out well, and I thought that not seeing the power button was the best route aesthetically."





## Second Place: TRIGINTA (by masbuskado)

"I spent about two months working on the design and concept, and it took me about 20 days to complete the whole setup," says Arturo Betances, aka masbuskado. "The main idea was to make a 'number 30' case from scratch to celebrate the 30th anniversary of GIGABYTE. The case has the same dimensions as a midtower ATX case, and its main feature is of course the huge number 30 reservoir in one side. Everything was custom made to fit into place like a big puzzle. This project has 98 parts that hold the frame in place. Another feature that I want to showcase in this project is that I didn't want to have any visible cables or wires visible from any angle, so when I was designing the case in SolidWorks, I managed to come up with some nice ideas for obscuring them—even the GPU power cables, which is why the GPU is so heavily modded. My favorite part was getting back to work in SolidWorks. I brainstormed for about a week and drew the main concept in CorelDraw, then I was able to import my work into SolidWorks to finally see the 3D version of my main idea. From there, I had to add or remove some of the features that I planned for the project. At the end I truly got the results I envisioned."



## Third Place: Rehab (by InsolentGnome)

"It took about four months of working on Rehab on the side to bring it all together," Dave Cathey, aka InsolentGnome, says. "The only original pieces of the case remaining are the rails, the side panel, and half of the roof panel, and all of those got customized to some degree. Nothing was left untouched. The inspiration for it was the '34 Ford coupe. Half of the case was set up like an engine bay in the old coupes, so the case was widened at the back to give it a wedge shape and more space, and then half of the roof was replaced with hinged aluminum 'hood.' For the engine side, I flipped the layout of the case, reversing the motherboard on a custom tray and tried to place components to mimic the look of engine parts. The pump wound up spoofing the master cylinder, the GPU the valve cover, and the motherboard the block. To give it even more of a hot rod look, I used an automotive overflow catch can as the reservoir and put automotive gauges in as well, which actually work and monitor some system vitals. The other side of the interior got a custom trunk treatment, with a cloth panel covering, billet accents, and a fire extinguisher for the fun of it. The exterior got metallic blue paint and old-school flames along with a new side window, back panel, and custom front grille."



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# Launch Platform

## New Chipsets & New Boards Kick Off A New World Of Build Possibilities

Chipset launches are unique in the realm of computing because they tend to act as a bellwether for the technologies that are on the verge of going mainstream. They're also gatekeepers that can kill a fledgling standard dead if Intel or AMD decide to scratch it from the block diagram at exactly the wrong moment. We have a love-hate relationship with chipset launches; they're like a line in the sand that lets us look back to see how far we've come, but they also show us how far behind the curve our current systems have fallen. With the launch of Intel's new 200 Series chipsets, the urge to upgrade intensifies once again.

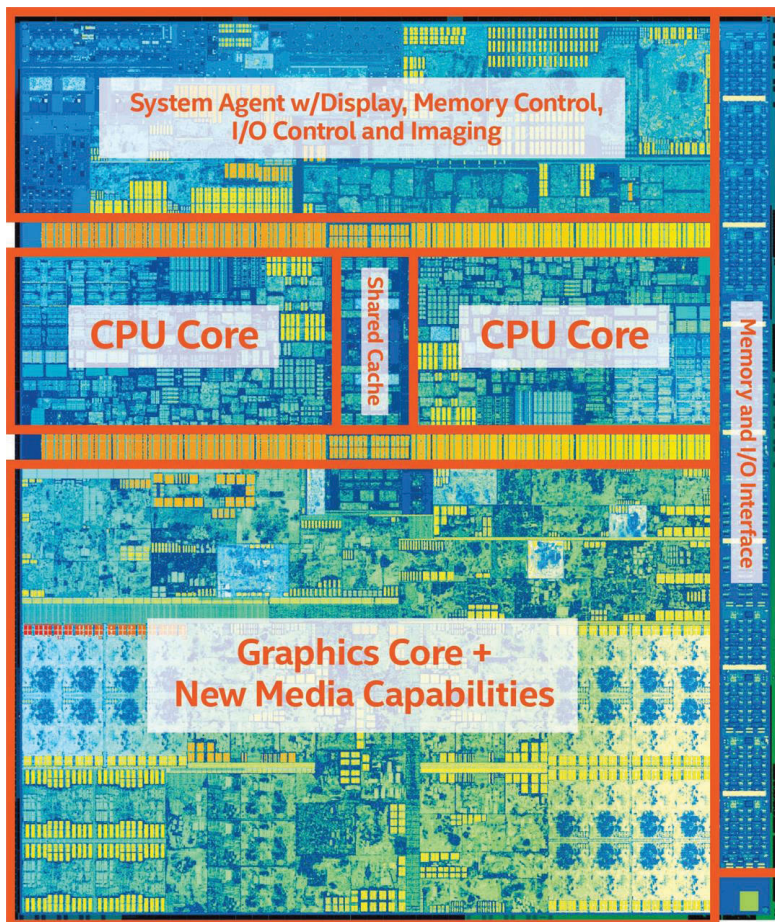
### A Skylake Refresher

Intel's 6th generation processor family, also known as Skylake, was designed in tandem with the supporting 100 Series chipset. The flagship Intel Core i7-6700K and its less powerful siblings are built on a 14nm manufacturing process, like the Broadwell-based processors before them that debuted in early 2015. As a tock in Intel's long-running tick-tock cadence (a new process followed by a new architecture), Skylake processors were redesigned from the ground up, with overclockers and enthusiasts in mind.

Of course, Intel continued its practice of unlocking the multipliers of its K Series Skylake processors, but overclockers using the platform also enjoyed significantly more granular clocking capabilities. The PEG/DMI domain features an isolated 100MHz clock, so users no longer have to bother with PEG/DMI ratios. Additionally, the BCLK has full support for fine-grain overclocking. Although still dual-channel, 100 Series chipset-



MSI's Z270 GAMING PRO CARBON motherboard harnesses the full power of the Z270 chipset. And it ain't half-bad-looking, either.



Intel's new Kaby Lake processors feature a handful of enhancements made to the graphics and media encode/decode engines.

based motherboards support DDR4 and DDR3L memory. In the months following the 100 Series chipset release, we have witnessed a gradual decline in DDR4 prices and an inverse climb in clock speeds.

### Pumping The Brakes With Kaby Lake

Kaby Lake's first processors to see the light of day were actually the mobile variants, and they have been available in laptops and mobile devices for several months already. These, as well as the processors launching in the first half of this year are the third product line to rely on the 14nm manufacturing process, although Intel has made tweaks to the formula,

calling the process 14PLUS, 14nm+, or 14FF+. The key takeaway for 14PLUS is a transistor with improved transistor channel strain, a higher fin height, and larger pitch; these factors reduce the IC density and allow for up to 12% higher performance. This is good news for overclockers.

If we were following Intel's traditional release schedule, then Broadwell was the tick and Skylake was the tock, making Kaby Lake the odd man out. But last year, Intel announced that for the foreseeable future it was abandoning tick-tock for a new scheme, called PAO (Process-Architecture-Optimization). In this scenario, Kaby Lake is the Optimization phase. Although this new scheme signals a slower pace for

Intel, this is good news for those of us who upgrade parts on a piecemeal basis. Skylake processors will work in Kaby Lake motherboards, and in most cases, Kaby Lake processors will work in Skylake motherboards. As we went to press, nearly all Skylake motherboard manufacturers have released or announced the impending release of a BIOS update that would make their boards compatible with Kaby Lake.

We mentioned Kaby Lake processors would have higher clocks, but how much higher? The Core i7-7700K, for example, has a 4.2GHz base clock and a Turbo frequency up to 4.5GHz. Remember, the Skylake flagship has 4GHz base and 4.2GHz Turbo clocks, giving Kaby Lake a 200MHz to 300MHz advantage. The more nimble Kaby Lake processors will also be able to change clock speeds faster, in as few as 10ms, thanks to a technology called Speed Shift v2. Skylake processors took as much as 30ms to change clock speeds. Other Kaby Lake processor highlights include enhanced graphics cores and support for Intel Optane Technology, but we'll dig into that more later.

In addition to the couple of mobile Kaby Lake processors launched late last year, Intel plans to release at least 11 quad-core desktop processors based on the Kaby Lake microarchitecture.

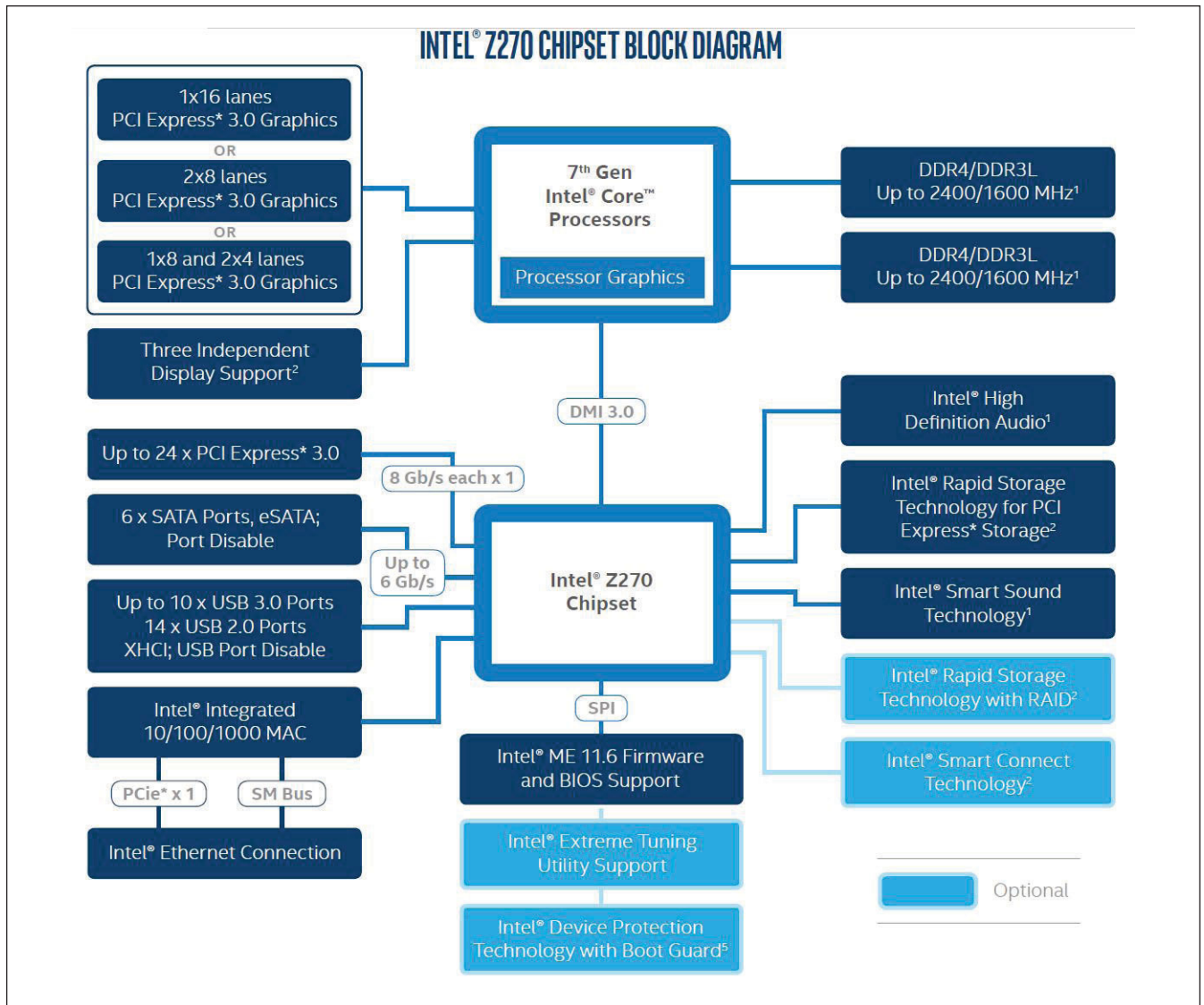
### On Point With Union Point

The 200 Series chipset, code-named "Union Point," is built around the LGA 1151 socket, just like the 100 Series chipset. It'll come as no surprise that there are multiple 200 Series chipsets, each targeting a different market. The mainstream 200 Series segment will consist of three chipsets, the Q270, H270, and H250. The business and office PC-friendly chipset is the B250. The one we're most interested in, however, is the Z270 PCH, which features the best support for overclocking and enthusiast-class PC components.

### Music To Your Ears

When you pair a motherboard based on Intel's Z270 chipset and a 7th Generation Intel Core processor, you get access to Intel Ready Mode Technology, a new alternative to the traditional sleep mode that lets the





The block diagram of the Z270 chipset gives you a good idea of how the processor and chipset work in tandem to make a solid platform for enthusiast PCs.

PC save power, but wake instantly to display notifications and stay up-to-date all the time. The Z270 chipset also supports Intel Smart Sound Technology, which adds an integrated audio DSP (Digital Signal Processor) that enables clear voice recognition and high-fidelity audio capture without adversely affecting system performance.

### Core Processor Eye Candy

Kaby Lake processors feature an enhanced media engine that together with a 200 Series chipset-based motherboard supports hardware-based encode and decode of 4K

HEVC Main, HEVC Main10, VP9 8-bit, and H.264 profile videos. It also adds VP9 10-bit decode in hardware and native HDCP 2.2 support. This results in significantly more power-efficient video playback and media creation for those who enjoy and work with 4K content. Other benefits of the platform include support for Wide Color Gamut and HDR, as well as more immersive 3D movies thanks to Intel InTru 3D technology.

### Intel Optane Technology

In last month's Whitepaper, we wrote at length about phase-change memory from

IBM. Intel and Micron jointly developed their take on PCM, called 3D XPoint (pronounced "crosspoint") memory, which hopes to deliver DRAM's speed, but in a nonvolatile state like SSDs and HDDs and at the cost of today's TLC (Triple Level Cell)-based storage devices. Intel's Kaby Lake processors support 3D XPoint in the form of Optane Technology, which supports non-volatile memory (NVM) devices that measure latency in tens of nanoseconds instead of tens of microseconds (like current SSDs), but with significantly higher densities than current NVM. It's like the fastest of today's SSD, on steroids.

## Intel Z270 Chipset Features

Intel's 7th Generation Core processors have access to a single x16 lanes PCIe 3.0 interface, which can be split into two x8 lanes, or a single x8 and two x4 lanes. As in the 100 Series, the processor connects to the chipset using a DMI 3.0 bus. They can also output to three independent displays and the internal memory controller is dual-channel, with support for DDR4 and DDR3L at speeds up to 2,400MHz and 1,600MHz, respectively. That doesn't sound very fast, but based on our experience with the handful of Kaby Lake motherboards in this issue, OC speeds are supported up to 4,000MHz and possibly beyond.

On the chipset side of the block diagram, there are now 24 PCIe 3.0 lanes available, with each one capable of operating at up to 8Gbps. The 100 Series chipset, you'll recall, had four fewer PCIe 3.0 lanes to offer. From here on, the 200 Series and 100 Series chipsets are remarkably similar, with each featuring up to six SATA 3.0 ports (6Gbps), up to 10 USB 3.0 ports (5Gbps), and up to 14 USB 2.0 ports (480Mbps). Intel Rapid Storage Technology for PCI Express Storage enables support for three x4 PCIe

3.0 M.2 ports. The USB controllers let you selectively disable any one or multiple USB ports, giving publicly accessible PCs an added layer of security.

Networking on the 200 Series comes courtesy of an Intel 10/100/1000 MAC. We spoke briefly about the audio support improvements largely stemming from the 7th Generation Core Processors, but on the chipset there's still support for Intel High Definition Audio.

There are a handful of optional Z270 features that will vary from motherboard to motherboard. One of these is support for the Intel Extreme Tuning Utility, which is one of the better software-based overclocking applications we've used. Intel Rapid Storage Technology with RAID support is self-explanatory, and definitely something you'll want if insanely fast storage is high on your list of computing priorities. Intel has discontinued its Smart Connect Technology, which periodically wakes the PC to keep notifications, emails, and social media networks up-to-date, so you aren't likely to see it on many Kaby Lake-based systems. Intel Device Protection Technology with Boot Guard is a useful feature that

prevents the system's pre-OS environment from getting infected with malware.

## Less Is . . . Just Less

The block diagram for the Q270 chipset looks identical to that of the Z270. On the H270 and B250 chipsets, however, you'll have a less flexible PCIe 3.0 graphics interface on the processor, precluding multi-GPU setups. The H270 also gives you four fewer PCIe lanes from the chipset and two fewer USB 3.0 ports to work with. The B250 limits your options even further, with 12 PCIe 3.0 lanes, six USB 3.0 ports, and 12 USB 2.0 ports. Motherboards based on these pared-down chipsets will likely feature fewer of the available features overall to keep prices in line with customer expectations.

## Get Ready For Kaby, Baby

The unassuming chipset won't ever get the kind of attention a processor gets, or a top-tier GPU, and often they're forced to play second fiddle to the latest solid-state storage devices and overclocked LED-laden DRAM, but none of the above can stand on its own. Intel's latest 200 Series is going to bring a lot of great things to PCs in 2017 and beyond. ■

## Intel® 8/9 Series, 100 Series vs. Kaby Lake PCH HSIO

Capability	Intel® 8/9 Series	Intel® 100 Series (Skylake PCH-H)	Intel® 200 Series (Kaby Lake PCH-H)
Total HSIO & Flexibility	18 Total with limited flexibility	26 Total with high flexibility	30 Total with high flexibility
PCI Express Lanes	Up to 8 PCIe 2.0	Up to 20 PCIe 3.0	Up to 24 PCIe 3.0
SATA Ports	Up to 6 SATA 2.0 & 3.0	Up to 6 SATA 3.0	Up to 6 SATA 3.0
USB 3.0 Ports	Up to 6	Up to 10	Up to 10
DMI Speed	2.0	3.0	3.0
Intel® RST for PCIe Storage Ports (M.2 socket)	1 x2 port (PCIe 2.0) Intel® 9 Series only	Up to 3 x4 ports (PCIe 3.0)	Up to 3 x4 ports (PCIe 3.0)

There's not a whole lot of difference between the 100 Series and 200 Series chipsets, but Kaby Lake makes an ideal upgrade for those running Haswell or older processors.



# Hellfire Unleashed

## Patriot Enters The PCIe SSD Arms Race

**P**atriot is no stranger to solid-state drives. Over the years, power users could count on the company, which is based in Fremont, Calif., to be among the first to adopt new technologies and components. When SSDs were still in their infancy, Patriot recognized their potential and developed drives for enthusiasts who craved that unprecedented performance.

Now, these enthusiasts have recognized that unprecedented performance no longer means SSDs that operate over the 6Gbps SATA bus. Although slower SATA-based SSDs still have a home in most PCs, bottlenecks from the SATA bus itself have relegated 6Gbps SATA SSDs to second-tier storage duty. They're great for storing apps, games, and other files that aren't a top priority, but for the operating system and any programs that need unmatched throughput, a new champion has claimed the throne.

The PCI Express bus isn't a new innovation, clearly, but for years it mostly served up its considerable bandwidth to a system's graphics card(s).

Now, we've harnessed some of that bandwidth for SSDs. Combined with a storage interface that was built from the ground up to address solid-state drives' distinct characteristics (that would be NVMe, which has finally freed SSDs from the constraints of AHCI, a storage interface that was developed during the era of HDDs), the storage revolution was complete.

In early 2016, Patriot announced the impending arrival of its Hellfire PCIe SSD family. Later in the year, 240GB and 480GB drives materialized. True to its name, Hellfire delivers scorching throughput for blazing-fast performance. This didn't happen by accident, though, as Patriot took time to carefully choose and test individual components to ensure the Hellfire was a formidable PCIe SSD.

### Patriot's Plans

Like the company does with all of its hardware, Patriot began development on the Hellfire drives with very specific goals in mind. According to Les Henry,

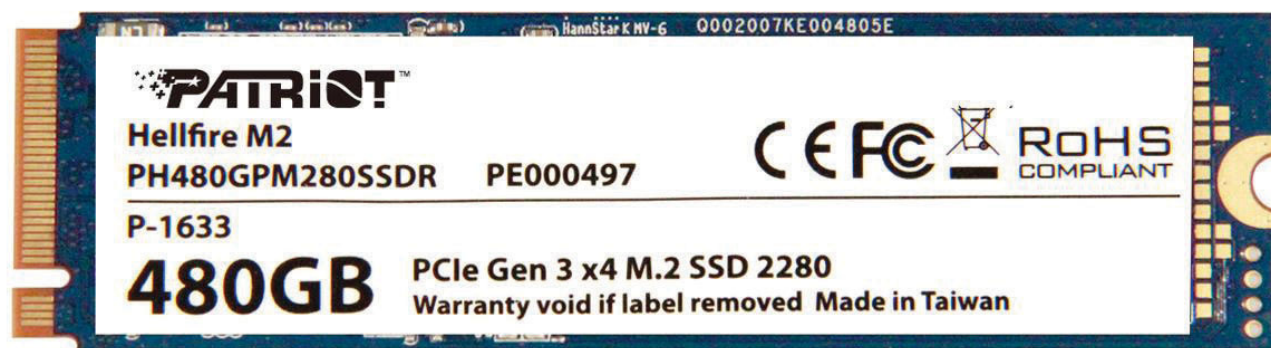
Patriot VP of Engineering, performance was key.

"Since this was our first PCIe drive of any type, we were really focused on coming out with a drive with high performance," Henry says.

Because SSDs impact PC performance in so many tasks, and because enthusiasts tend to be a demanding bunch, Patriot's engineers knew they had to select outstanding components from established manufacturers. Ultimately, Patriot settled on a storage controller from Phison and Toshiba MLC NAND. These would become the fundamental building blocks of Patriot's initial Hellfire PCIe SSDs.

### Hellfire Under The Microscope

Although consumer-grade PCIe SSDs have existed for a few years, drives that use both the PCIe bus and NVMe interface are relatively new. The number of available storage controllers designed for these cutting-edge drives is small compared to 6Gbps SATA SSDs. Henry says Patriot relied on its established partnership with Phison to



The SSD is dead, long live the SSD! In 2016, 6Gbps SATA solid-state drives accepted defeat that a newer, more powerful class of SSD was ready to take over as the new performance champ. Patriot, which has always had a keen understanding of what enthusiasts want, joined the fray with a pair of powerful PCIe SSDs, the 240GB and 480GB Hellfire drives.

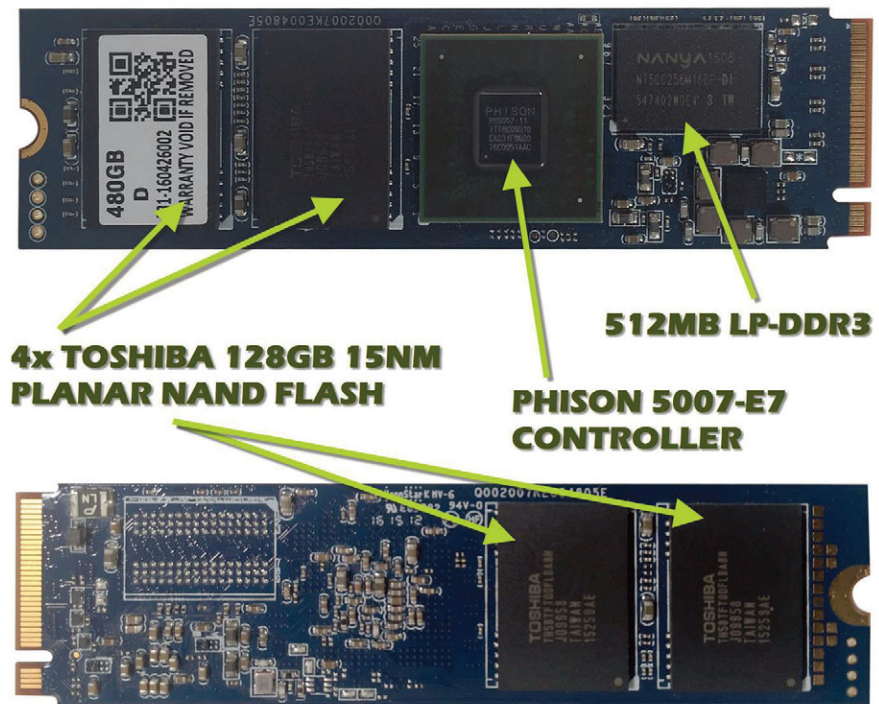
find a controller that would be a good fit. Eventually, Henry says, Patriot settled on the 5007-E7.

“When we first started investigating PCIe solutions, there really were not many options in terms of PCIe controllers to choose from,” he explains. “There were only a handful of PCIe NVMe SSDs out in the market. Patriot has had a very good partnership with Phison, for many years, and we decided to test out their 5007-E7 controller for our Hellfire line. After testing the drives, we compared our results to some of the other drives that were already on the market. We were very pleased with the performance results and decided to launch with their controller.”

The Phison 5007-E7 controller that calls the shots for the Hellfire is an 8-channel chip with a few tricks up its sleeve. In addition to supporting MLC and TLC NAND, the 5007-E7 can also address 3D NAND, an attribute that could pay dividends in the near future, as Patriot explores using 3D NAND in future drives. As far as standards go, Phison’s controller is compatible with PCIe 3.0 x4 and NVMe 1.1b. Phison also includes ECC (120bits/2KB), static and dynamic wear leveling, and end-to-end data path protection.

High-performance MLC NAND pairs quite nicely with Phison’s 5007-E7, and Toshiba answers the call for the Hellfire drive. Specifically, the SSDs use planar NAND (which means individual cells are spread across the die horizontally in a single layer; this has been the established process for several years) fabricated using a 15nm process. Patriot plants packages of NAND on both sides of the Hellfire’s PCB. Consistent with Patriot’s goal of entering the market with a high-performance PCIe SSD, Henry says the company decided against cheaper but less effective TLC NAND.

“One advantage that we have found with MLC over TLC NAND is the performance increase in the 4K write IOPS. Since we were looking at performance as the key feature for our Hellfire line, we decided to go with



Working together, Phison’s 5007-E7 controller and an array of Toshiba 15nm planar MLC NAND Flash let Patriot’s Hellfire solid-state drives do amazing things. Both the 240GB and 480GB drives are capable of throughput that puts 6Gbps SATA SSDs to shame.

MLC NAND over TLC NAND. The other main advantage you get with MLC NAND over TLC NAND is an increase in TBW [total bytes written, a measure of a solid-state drive’s endurance].” Henry adds, however, that Patriot is exploring 3D TLC NAND for future PCIe SSDs in order to expand the company’s offerings.

Currently, Patriot only offers its Hellfire drives in an M.2 form factor without an add-in adapter card that connects to a motherboard’s PCIe slot, although Henry isn’t ruling out such an option in the future. He explains that Patriot carefully examined the market and determined that most power users had motherboards capable of accommodating M.2 drives without an adapter.

Enthusiasts who lack an M.2 slot for the Hellfire still have an easy alternative to add one of Patriot’s powerful SSDs to their system. By simply purchasing the right AIC, one can upgrade to the Hellfire by installing the drive in the

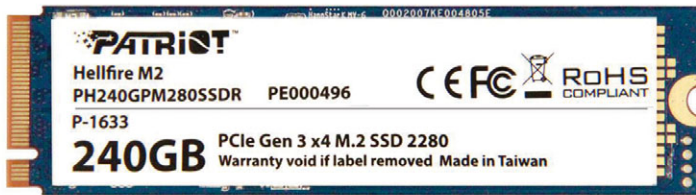
adapter card and then connecting the card to an open PCIe slot. Keep in mind that legacy motherboards may not give users access to PCIe 3.0 and/or NVMe, so the Hellfire may not deliver the same results as it would in a cutting-edge rig.

However, like the Hellfire’s NAND, Henry says that Patriot is investigating the possibility of introducing future Hellfire SSDs in a variety of form factors. “Going forward, we are looking at multiple options for PCIe storage,” he says, “such as an AIC, 3D TLC NAND for our next-gen M.2 drives, as well as coming out with a 2.5-inch U.2 SSD lineup.”

Patriot uses a cache of low-power DDR3 in its Hellfire drives. The 480GB has 512MB of LP-DDR3, and the 240GB drive has half that—256MB. Other features include TRIM support, bad block management, and advanced garbage collection.

The combination of Phison’s 5007-E7 controller, high-quality MLC NAND, and a modern storage interface





Available for a little over \$0.50/GB, Patriot's 240GB Hellfire M.2 SSD is a terrific option for budget-conscious builders who don't want to sacrifice performance. In most workloads, this drive nearly matches the 480GB Hellfire stride for stride.

add up to a pair of PCIe SSDs that are among the fastest consumer drives on the planet. To wit, Patriot advertises that both capacities of Hellfire deliver sequential reads of 3,000MBps when tested with ATTO. In sequential writes, only 100MBps separates the 240GB Hellfire from its bigger brother, with the drives humming along at 2,300MBps and 2,400MBps, respectively. You'll find a similar story with the Hellfire drives' random performance. Both SSDs pump out 170,000 IOPS on 4K reads; the 480GB Hellfire plows through random writes at 210,000 IOPS, while the 240GB version is capable of 185,000 IOPS.

### Sensors & Drivers

Eagle-eyed observers might notice that the Hellfire's thermal sensor peaks at 125 degrees Celsius, while Patriot rates the drive's maximum operating temperature at 70 C. Henry elaborates on the differing tempering ratings: "Our thermal sensor is currently built into the controller. This means that when you get a temperature reading from our drives, you are actually just seeing the temperature of the controller and not the whole drive. Many of our competitors have a separate thermal sensor located on the PCB, which gives an accurate reading of the drive. When you compare our temperature reading compared to the competition it looks like our Hellfire drive is running much hotter. Unfortunately, it's not an accurate comparison."

Henry says that Patriot's next generation of PCIe SSDs will include a thermal sensor on the PCB in order to obtain a temperature reading for the drive as a whole. He also mentions the possibility of installing a heat spreader over the controller of future models, which would keep the drives' thermals in check, particularly under heavy workloads.

A couple of PCIe SSD manufacturers have developed specific NVMe drivers for their drives, but Patriot opted to stick with Microsoft's native NVMe driver. Henry says that this driver is compatible with and optimized for all NVMe SSDs, but he doesn't rule out the possibility of Patriot introducing its own NVMe driver in the future.

### Play With Fire

Expect 2017 to be an even busier year for Patriot, as the company's master plan includes new drives for the New Year. On the other hand, if your PC is in dire need of an infusion of speed, the current duo of Hellfire PCIe SSDs are ready to roll. ■

### HELLFIRE BY THE NUMBERS

Specs	Patriot Hellfire 480GB	Patriot Hellfire 240GB
Interface	PCIe 3.0 x4, NVMe	PCIe 3.0 x4, NVMe
Controller	Phison 5007-E7	Phison 5007-E7
NAND	Toshiba 15nm MLC	Toshiba 15nm MLC
Max advertised sequential read/write (ATTO)	3,000MBps/ 2,400MBps	3,000MBps/ 2,300MBps
Max advertised random 4K read/write (aligned)	170,000 IOPS/ 210,000 IOPS	170,000 IOPS/ 185,000 IOPS
Form factor	M.2	M.2
Warranty	3 years	3 years
MSRP	\$230	\$130

### Benchmark Results\* - Patriot Hellfire 480GB

<i>CrystalDiskMark 5.1.2</i>	
Sequential read	1301
Sequential write	1536
4K read	45.71
4K write	154.5
Sequential read (QD32)	2777
Sequential write (QD32)	1545
4K read (QD32)	721.9
4K write (QD32)	581.1
<i>AS-SSD</i>	
Sequential read	2316.19
Sequential write	1293.81
4K read	53.57
4K write	125.59
4K read (64Thrd)	936.21
4K write (64 Thrd)	747.94

\*Results in MBps

**Test System Specs:** Processor: Intel Core i7-6700K; Motherboard: GIGABYTE GA-Z170X-Ultra Gaming; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 32GB DDR4-3200; Storage: 240GB Intel SSD 730 Series; OS: Windows 10 Enterprise

## Modder Q&A: Gary Murphy

# A Place For Everything & Everything In Its Place

Gary "NavyChief" Murphy has won *CPU's* Mad Reader Mod contest twice; his QuakeCon 800D mod was on the cover of our August 2013 issue, and his Toxic Envi mod shared the September 2014 cover with winners from two other categories at that year's QuakeCon event. His uber-impressive BAWLS mod won first place at the 2016 DreamHack Austin event and also took second place at this year's QuakeCon mod contest (Case Mod category).

**Q** : You've been very competitive in quite a few QuakeCon mod contests now. How many times have you attended QuakeCon, and how many times have you entered the mod contest there?

**GM** : My first QuakeCon was in 2009 when it was at the Gaylord Texan hotel. I went as a General Attendee to see what this event was and fell in love with what I experienced. To have so many PC gamers and modders in one area is absolutely thrilling. I can talk shop with other modders and learn new techniques firsthand. This year was my eighth QuakeCon and will not be my last by any measure. In fact, the QuakeCon case mod contest (run by Modders-Inc) is what got me interested in case modding. In 2010 and 2011 I watched the case mod contest closely and looked at what the winning builds did to set them apart from the other entrants. I thought, "That doesn't look too difficult. Let me see what I can do." I have entered the case mod contest four times (2012, 2014, 2015, and 2016). The only gap was 2013; I volunteered to be a guest judge for the contest that year. My tally for this event stands at two first-place wins, one second-place, and one third-place finish.

**Q** : Back in 2013, you told us that you had built other systems in the past, but that your orange QuakeCon 800D rig was your first mod. How many mods have you completed since then?



Gary "NavyChief" Murphy and his award-winning QuakeCon 800D mod.

**GM** : I have completed three case mods since that first attempt (Toxic Envi, BAWLS, and Apeiro). The Toxic Envi and BAWLS builds were made for the QuakeCon case modding competition, while the Apeiro build was done for the 2016 GIGABYTE 30th Anniversary Mod2Win case mod challenge. With each build, I try and challenge myself to incorporate a new technique or style. My first mod (QuakeCon 800D) used vinyl tubing, my next (Toxic Envi) used acrylic tubing, and the BAWLS build utilized chrome-plated copper tubing. For my most recent build (Apeiro), I decided

to try my hand at fabricating a custom water reservoir and replacing the front panel with an infinity mirror.

**Q** : We've seen many, many first-time mods, and it's fair to say you came out of the gate pretty strong. What skills did you already have when started modding, and which ones did you have to develop?

**GM** : My only real initial skill was planning. I always do a ton of research before and during each build. I typically spend at least two months thinking of



a theme, searching the web to ensure it hasn't been done before and that it is technically feasible. Only then do I begin the process of selecting a case, color scheme, and possible hardware configurations. If a design is themed to a company or product, I typically contact the company to ensure I do not violate any trademark use restrictions. Most companies are extremely supportive and appreciative of me taking the time to ask permission first. Almost all of my hardware and fabrication skills have been developed via the time-tested trial-and-error method. I have learned a lot by watching videos and reading build logs to develop my skillset. The educational aspect is a constant process and cannot be overlooked. With new tools and technologies being developed all the time, you must be open to new ways of doing things.

**Q : Did the work of any specific modders inspire you when you got started?**

**GM :** Since I have seen the work of so many modders, it is really difficult to narrow it down to any one person. The modding community as a whole has inspired me to broaden my horizon and try new ideas. Talking with other modders at QuakeCon also helped to alleviate my initial fears. The

modding community is all about helping each other, and new modders are always welcome to ask questions. It is this "modders helping modders" environment that keeps me coming back for more each year.

**Q : What modder would you say inspires you the most today?**

**GM :** I would have to say that the Modders-Inc duo of Dewayne Caryl and Craig Tate keep inspiring me each and every year. They run the case modding contest at QuakeCon and continually push us to step up our game. After every QuakeCon, they hold a podcast and talk about the case mods and how the event went. I have learned so much from those recordings. Their feedback is both critical and honest. They won't hold anything back, so be prepared for the brutal truth. The key is to actually listen to their feedback and make the appropriate changes, if necessary. Their good nature and extensive knowledge lends them credibility that is hard to match. They really run a good event at QuakeCon and it is becoming one of the major case mod events in North America.

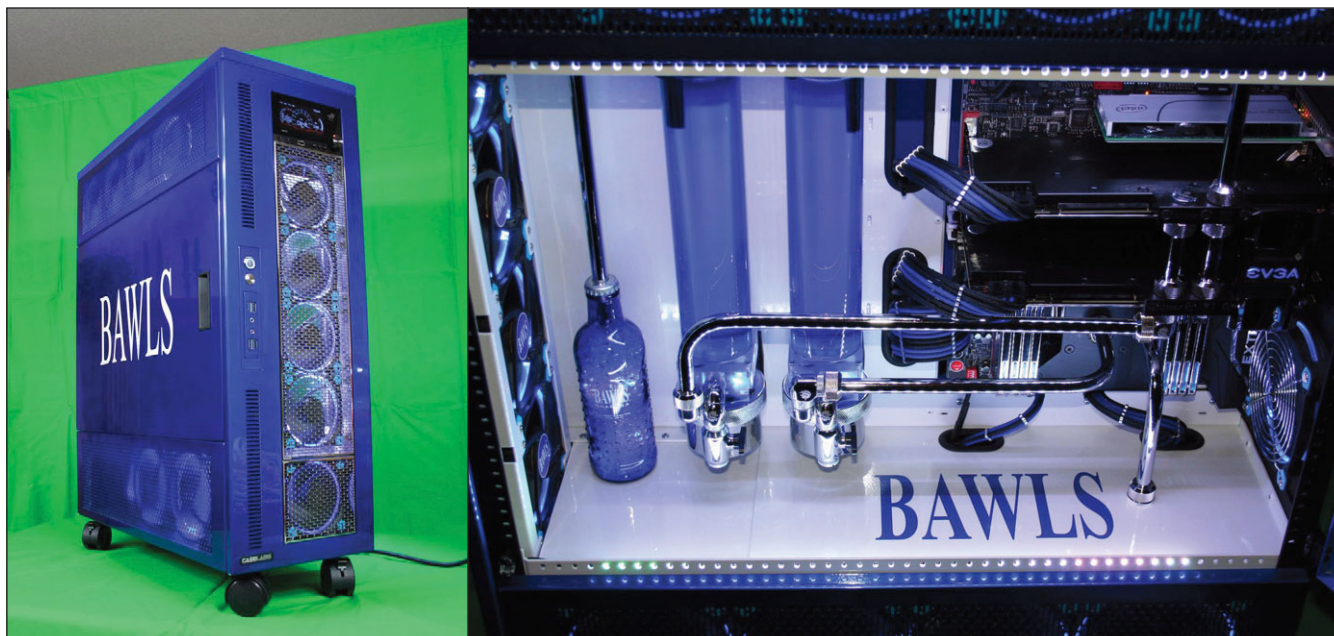
**Q : All of your QuakeCon entries so far have been for the Case Mod category—**

**traditional mods of existing stock cases. Have you given any thought to entering a Scratch Build or Bethesda/id mod?**

**GM :** I have never even considered the Scratch Build category. I just do not have the skillset to actually build a case from scratch; at least not at this point in time. With the ever-increasing plethora of PC cases available on the market, I just don't see the need to create my own. As for the Bethesda/id theme, I have never really contemplated that one, either. I prefer to develop a build with minimal restrictions and to let my imagination run freely. Limiting myself to a specific theme such as a Bethesda/id concept just does not sound reasonable. Now, if I come up with a theme that could fit into that category, then I would definitely consider it. The theme should always come first; once finished then I can decide which case mod category to enter the build into.

**Q : What's your favorite mod of all the projects you've done, and why?**

**GM :** My favorite would have to be the BAWLS build. The sheer size of it—it's 3 feet tall—and the chrome bling get a lot of attention. It was fun to build a



Murphy's favorite project to date is a tribute to his favorite energy drink, BAWLS Guarana.

case of that size (a big thanks to CaseLabs), but filling it up was really challenging. The STH-10 has an extreme amount of interior space! I even decided to try spray painting the case instead of powder coating. The copper tubing was actually easier than I thought and the chroming came out amazing. In fact, I ended up chroming the front grilles, SLI bridge, memory spreaders, and pump covers. Thankfully, this case came with an option for mounting wheels!

**Q** : Your mods all seem to have incredible paint. Is that kind of your specialty, or is there some other technique that you consider your strong suit?

**GM** : I would have to say that I actually prefer powder coating over spray painting. Powder coating provides a very durable finish and a wide variety of colors. As for my strong suit, that would definitely be cable management. Most anyone who looks at one of my builds comments that they are so 'clean' and organized. Dewayne Carel categorized my builds as "showroom quality" in one of his podcasts. At first I didn't know what to think of that, but after contemplation I would have to agree with his summation. My modding style is definitely geared towards hiding anything

that would detract from the overall build theme. Cabling and clutter are the biggest culprits. Your eyes are instantly drawn to the spiderweb of cabling that is evident in most builds. Cable management is taken into account during my planning phase, since it is something that cannot be left until the end. Only through proper planning and preparation can the build be completed successfully. Plan for every cable pass-through in the early stages and it will make cable management a breeze at the end.

**Q** : Do you have a project started for the 2017 QuakeCon yet?

**GM** : I am actually thinking about volunteering to be a guest judge again. In 2013 it was such an eye-opening experience to see what goes into judging one of these events. I think it is time to lend my experience and help expand the judging pool. Each year the number of entrants into the case mod event keeps expanding and they are in need of qualified judges to handle the demand. I also just finished a build for the GIGABYTE 30th Anniversary Mod2Win case mod competition. The results of that event will be announced on December 1. [ED. NOTE: You'll find coverage of the top three mods in this issue!] Now, this is not to say that I won't bring a new build to QuakeCon, just that it will not be entered into the case mod competition.

**Q** : Do you attend any other LAN parties aside from QuakeCon?

**GM** : Texas is becoming a real powerhouse with regards to LAN events. There are several local events that I like to attend: FadeCon, PowersGaming, and DreamHack Austin. FadeCon and PowersGaming are local LANs that are fun and keep me in touch with my gaming friends. DreamHack Austin is another major gaming LAN but definitely getting larger with each year. This event even has its own case modding competition (run by CPU magazine). I was lucky enough to win that event in 2016 and am looking forward to seeing what 2017 will bring.

**Q** : What would you say is your favorite modding-related tool?

**GM** : It would definitely have to be my Dremel. This device is extremely versatile, with many possible configurations. It can cut, drill, and sand with equal precision and speed. I also recently picked up the Dremel Moto-Saw and Table Press. The other essential tools would be a reliable hand drill and jigsaw. Nothing really high-tech can be found at my workbench, just a lot of handheld tools and accessories.

**Q** : What is the hardest part of a mod for you to get the way you want it?

**GM** : It would have to be cable management. As my handle states, I am a retired U.S. Navy Chief Petty Officer. The Navy instilled in me that there should never be any gear adrift—nothing out of place. I place a huge emphasis on hiding cables and presenting a clean, cohesive theme. I will often spend whole weekends trying to find a way to hide any cable that just looks out of place. I have a very critical eye and am a little OCD with regards to getting everything just right. Definitely the hardest part of my builds and the most time-consuming.

**Q** : It's time for Five Quick Questions!

1) BAWLS Original or Root Beer?

BAWLS Original FTW!

2) Powder coat or paint booth?

Powder coat.

3) Cowboys or Texans?

Cowboys!

4) Deep dish or thin crust pizza?

Thin crust.

5) Counter-Strike: GO or Overwatch?

Counter-Strike: GO. ■



Toxic Envi, a Murphy mod that took first in the QuakeCon 2014 Case Mod category.



# Mecha Warriors

The rise, fall, and return to prominence of the mechanical keyboard is one of the more bizarre turns in PC technology.

In the late 1980s, the majority of PC users used mechanical keyboards, such as the IBM Model M, where each key has its own switch that provides a tactile and auditory indication when a keystroke is registered. Despite the feedback advantages, in the early 1990s keyboard makers began to replace mechanical switches with membrane and rubber dome keyswitches. Membrane keyboards were cheaper and easier to mass-produce than mechanical designs and quickly took over. Gone but not forgotten, the mechanical keyboard became a niche product that power users and gamers had to seek out.

This sad state of affairs persisted until 2010, when a few keyboard manufacturers reintroduced mechanical switches in keyboards designed specifically for gamers. Gamers need quick, precise responses from each keystroke, and the mushy, weak feedback of membrane switches didn't cut it. As most anyone who's used a mechanical keyboard can attest, it's easy to feel a mechanical keyswitch's actuation point.

Today's mechanical switches are not built like the beige, buckling spring keyboards of the 1980s. Modern mechanical switches feature a plastic stem that, when pushed down, lets two metal contacts register a keystroke. A metal spring on the bottom of the stem provides resistance and pushes the stem back up. Stems of different shapes and sizes customize the switch's tactile and acoustic feedback. Some switch types, for example, feature a bump in the stem to create physical feedback when a key is pressed. Mechanical keyboards with brown or blue switches are two popular switch options that provide tactile feedback.

Other switches are linear (no bump), but you'll feel increased resistance from the spring as you get close to the key's bottom travel point. Red and black are common linear switch types. Actuation force varies by the type of switch to further optimize the keyboard for a specific task. Lower actuation force is good for fast responses, so it's especially handy in games where you need to repetitively tap keys. Higher actuation forces help to avoid accidental key presses when precision is critical.

There are a handful of other switch technologies around, as well. Optical switches, for instance, rely on light sensors to actuate, rather than metal contacts. We've also seen several hybrid designs that blend mechanical and membrane technology. The following pages detail what type of switches each keyboard uses, as well as other features that make it stand out from the crowd.

## Patriot Viper V730 Mechanical Keyboard

\$79.99

[www.patriotmemory.com](http://www.patriotmemory.com)

**Why You'll Dig It:** Built with an aircraft-grade aluminum chassis, the Viper V730 is a sturdy, affordable mechanical keyboard. It doesn't have all of the bells and whistles of the other models in Patriot's Viper lineup, yet isn't devoid of features, either. The V730 is built with Kailh Brown mechanical switches to deliver a tactile response without being "clicky." Thus, a slight bump is the only feedback when a switch actuates, ideal for environments where noisy keystrokes could be problematic. Red LEDs backlight the keys, and you can pick among six effect modes and six brightness levels. 104-key rollover and anti-ghosting capabilities ensure that the V730 will never miss a command. Onboard multimedia controls let you adjust playback without having to ALT-TAB out of your current application or game.

**Who Should Apply:** Power users who want a quality mechanical keyboard with tactile feedback that doesn't distract with noisy clicks during use.

Interface: USB

Switches: Mechanical (Kailh Brown)

Backlighting: Red LED



## MSI GK-701 Mechanical GAMING Keyboard

\$105.99

[us.msi.com](http://us.msi.com)

**Why You'll Dig It:** MSI's GK-701 Mechanical GAMING keyboard is built with Cherry MX Brown switches that provide a tactile bump, without any click sound, when the switch actuates. The soft Cherry MX Brown switches make this keyboard ideal for enthusiasts wanting a good middle-of-the-road option that's appropriate for both typing and gaming. MSI engineers the GK-701 Mechanical GAMING Keyboard with N-key rollover to ensure that it will register every keystroke. Gamers can also disable the Windows key to prevent accidental keystrokes from interrupting the action. Multimedia access keys are onboard, too, so you can conveniently control media playback. MSI knows that you don't replace your keyboard too often, so it designed the GK-701 to last. The laser-etched keys resist wear, and each key is rated for 50 million keystrokes. The red, individually backlit keys offer four brightness levels.

**Who Should Apply:** Enthusiasts who want a solid mechanical keyboard with Cherry MX Brown switches and LED backlighting.

Interface: USB

Switches: Mechanical (Cherry MX Brown)

Backlighting: Red LED





## Corsair K70 LUX RGB

\$159.99

[www.corsair.com](http://www.corsair.com)

**Why You'll Dig It:** Customization is the name of the game with the K70 LUX RGB. Corsair lets you pick between Cherry MX RGB Blue, Brown, or Red keyswitches, and the per-key RGB lighting gives you complete control of each key's color. Large font on the keycaps allows the RGB lighting to brightly shine through. The K70 LUX RGB also includes a set of textured and contoured keycaps, such as W, A, S, and D keys, that provide a different grip and feel for the commonly used keys in FPS and MOBA games. The keyboard supports CUE (Corsair Utility Engine) Link, so the RGB illumination can match up with a CUE-enabled mouse and headset. Within the CUE Link utility, you can also set up keybinds, macros, and action timers to program the K70 LUX RGB however you like. A USB pass-through port is convenient for connecting a mouse or other USB devices. The plank itself is made of a black-anodized, brushed aluminum frame that will stand up to travel and gaming duties.

**Who Should Apply:** Gamers who want a keyboard they can tweak to suit their individual preferences.

Interface: USB

Switches: Mechanical (Cherry MX RGB Blue, Brown, or Red)

Backlighting: 16.8 million colors, per-key RGB



## GIGABYTE XK700

\$99.99

[www.gigabyte.us](http://www.gigabyte.us)

**Why You'll Dig It:** GIGABYTE designs the XK700 with individually backlit RGB LED keys, so you can customize the color of each and every key. Wave, cycle, and breathing lighting effects are available, as well, if you want something more festive. The XK700 comes with 512KB of onboard memory to let you save color preferences and macro combinations. The linear TTC Red keyswitches feature an anti-ghosting matrix design and support N-key rollover across all areas of the keyboard, rather than just the alphanumeric keys. GIGABYTE uses an island-style keyswitch design to keep accidental spills from damaging the circuit board. The black keys stand out on the aluminum faceplate, and GIGABYTE also provides 12 orange replacement keycaps to visually define critical gaming keys. Adjustable non-slip rubber feet let you set the keyboard at the most comfortable height.

**Who Should Apply:** Modders and enthusiasts who want a mechanical keyboard with RGB keys to match a color theme.

Interface: USB

Switches: Mechanical (TTC Red)

Backlighting: 16.8 million colors, per-key RGB



## MSI Interceptor DS4200

\$34.99

[us.msi.com](http://us.msi.com)

**Why You'll Dig It:** The affordable Interceptor DS4200 features hybrid switches that combine the frictionless keystrokes of a membrane keyboard with the tactile response of a mechanical switch. For gaming duties, MSI equips the Interceptor DS4200 with 20-key rollover and anti-ghosting. Function keys along the top row let you control volume, skip tracks, and play or pause tracks. The Interceptor DS4200 features a Gaming Mode that will disable the Windows key. You can also switch the W, A, S, and D keys with the arrow keys to exchange their respective functions, which is ideal for left-handed gamers. MSI indicates that the keyboard is water repellent, an always helpful feature in a keyboard. Multicolor LEDs run beneath the keys, and you can adjust their brightness as well as lighting effects.

**Who Should Apply:** Gamers on a budget who want an eye-catching keyboard.

Interface: USB

Switches: Membrane

Backlighting: Multicolor



## Patriot Viper V770 RGB Mechanical Keyboard

\$149.99

[www.patriotmemory.com](http://www.patriotmemory.com)

**Why You'll Dig It:** We enjoyed our time with Patriot's Viper V760 RGB Mechanical Keyboard, and the new V770 features several notable additions. There are five dedicated, programmable macro keys on the left side of the plank for easy access to preset keystrokes. Patriot also adds audio pass-through ports and a USB hub. The V770 RGB Mechanical Keyboard features Kailh Red switches to deliver a smooth linear action that helps with rapid-fire keystrokes in RTS and shooter games. The V770 keys are individually backlit with full-spectrum RGB LEDs, and Patriot includes a variety of lighting effects that you can control via the dedicated light effect keys or the downloadable utility. Onboard volume control is available via a wheel in the upper-right corner of the chassis.

**Who Should Apply:** Gamers who require dedicated macro controls and want the fast action of mechanical Red switches.

Interface: USB

Switches: Mechanical (Kailh Red)

Backlighting: 16.8 million colors, per-key RGB





## Cooler Master MasterKeys Pro L

\$169.99

us.coolermaster.com

**Why You'll Dig It:** Cooler Master mounts Cherry MX RGB keyswitches (Blue, Brown, or Red) to a reflective white plate for brilliant, bright illumination. Both the lettering and the area under the keycaps light up, and the RGB per-key backlighting lets you tweak the keyboard's illumination. Cooler Master provides a variety of custom effects, including Color Wave, Rain Drop, and Star Effect, to show off the LED lighting. An on-the-fly macro recorder and 512KB of onboard memory let you store profiles and macros without having to leave your game, open the keyboard utility, and program the macro. To power the macro system, Cooler Master installs an ARM Cortex M3 processor that ensures macro commands will execute instantly. Anti-ghosting and N-key rollover technology are present to register every keystroke.

**Who Should Apply:** Gamers who want a mechanical keyboard with bright LEDs that's available with a variety of Cherry MX switch types. We also like the keyboard's easy-to-configure, on-the-fly macro capability.

Interface: USB

Switches: Mechanical (Cherry MX Blue, Brown, Red)

Backlighting: 16.7 million colors, per-key RGB



## Bloody B840

\$99.99

www.bloodyusa.com

**Why You'll Dig It:** Bloody augments its blue-style keyswitches with optical technology to instantly (0.2ms) register keystrokes. Traditional metal switches, according to Bloody, often produce 18ms to 30ms delays due to metal bouncing. The B840 also features LK Sound Creator technology to produce the blue switches' "click," rather than relying on metal switches where the actuation sound tends to fade away over time. Bloody rates its LK Optic switches for 100 million key strokes. Bloody even optimizes the Spacebar for durability by adding dual springs, dual screws, and a balance bar. To prevent damage from spills, the LK Optic switches in the B840 are surrounded by a 6mm waterproof layer. A sturdy aluminum alloy frame with an anodized treatment adds to the premium look and feel. The keys are backlit with Bloody's Neon Glare to make the letters and numbers stand out in the dark.

**Who Should Apply:** Enthusiasts who want a long-lasting keyboard engineered to immediately register and precisely respond to keystrokes.

Interface: USB

Switches: Optical (LK Optic Blue)

Backlighting: Yes (Neon Glare)



## Rosewill RK-9000V2 RGB

\$169.99

[www.rosewill.com](http://www.rosewill.com)

**Why You'll Dig It:** Available in either Cherry MX RGB Blue or RGB Brown switches and laser-printed keycaps, Rosewill's RK-9000V2 RGB lets you program each key with its own brilliant illumination. You can also assign different functions to each key for ultimate control over the RK-9000V2 RGB's layout. Up to 50 macros can be saved into one of five profiles, which are accessible via the number row above the alphabetical keys. Rosewill builds in on-the-fly macro recording, so you can quickly create keybinds without the need to leave your game. The RK-9000V2 RGB comes with a detachable USB and PS/2 cable, which is convenient for both travel and compatibility. When connected via PS/2, the keyboard supports N-key rollover, while the USB cable allows for 6-key rollover. To keep the RK-9000V2 RGB stable while typing, Rosewill adds rubber pads to the tilt legs.

**Who Should Apply:** People who want the tactile feedback of Cherry MX RGB Blue or Brown keys, as well as those who want to avoid the hassle of customizing macros and lighting in a software utility.

Interface: PS/2 or USB

Switches: Mechanical (Cherry MX RGB Blue or Brown)

Backlighting: 16.8 million colors, per-key RGB



## GIGABYTE Force K85

\$89.99

[www.gigabyte.us](http://www.gigabyte.us)

**Why You'll Dig It:** GIGABYTE uses linear motion, Kailh Red mechanical switches in the Force K85 with an actuation distance of only 2mm for ultrafast keystrokes. The Force K85 also supports N-key rollover via GIGABYTE's Anti-Ghosting Matrix keyswitch design. The mechanical keys are rated for a 70-million keystroke lifespan, which is 20 million more than conventional mechanical keys, according to GIGABYTE. Vibrant, RGB LED backlighting illuminates each key, and you're able to choose from RGB's full 16.8 million color spectrum. The Force K85 features a row of quick access hotkeys that let you manage LED color, tempo, and brightness on the fly. You can also customize and save lighting effects in the GIGABYTE FORCE Configurator utility. GIGABYTE uses an island-style key layout to shield the keyboard from crumbs and spills that could permanently damage the keyboard.

**Who Should Apply:** Gamers looking for a mechanical keyboard with a short actuation distance and LED illumination.

Interface: USB

Switches: Mechanical (Kailh Red)

Backlighting: 16.8-million-color RGB





## Rantopad MT Mechanical Gaming Keyboard

\$159.99

[rantopadusa.com](http://rantopadusa.com)

**Why You'll Dig It:** Visually, Rantopad's keyboards stand out from the crowd. The MT Mechanical Gaming Keyboard, for example, is available with gold keycaps and a matching gold top panel, or blue keycaps and a blue panel. Either way, you can choose between Gateron Blue or Black keyswitches. The Blues are "clicky" switches with tactile feedback and a 55cN actuation force. The Black switches are linear with a 50cN actuation force. The Gateron mechanical switches are rated for 50 million clicks per key to deliver years of reliable use. You can remove the keyboard's top panel to easily clean under the keys. White LEDs backlight the keys for crisp visibility in a dark room. Speedy key registers are assured via the keyboard's N-key rollover and 1ms response time.

**Who Should Apply:** Power users who want a gaming-grade keyboard with a different look.

Interface: USB

Switches: Mechanical (Gateron Blue or Black)

Backlighting: White LED



## AZIO MK Retro

\$109.95

[www.aziocorp.com](http://www.aziocorp.com)

**Why You'll Dig It:** The typewriter-inspired MK Retro is an eye-catching mechanical keyboard. AZIO matches the old-school aesthetic with round, chrome-trimmed keys and "clicky" mechanical switches that also provide tactile feedback. Our testing found that recessed key switches feel similar to Cherry MX Blues, in terms of both audible feedback and actuation force. A piano black backplate further infuses the MK Retro with a first-class, old-school look. AZIO also built some modern amenities into the MK Retro, including N-key rollover, media and productivity shortcuts, and dust/spill resistance. You can adjust the keyboard's tilt angle via two round pillar feet on the rear of the frame. Just rotate the feet to raise or lower the keyboard tilt angle.

**Who Should Apply:** Enthusiasts tired of keyboards with the same boring look.

Interface: USB

Switches: Mechanical (similar to Cherry MX Blue)

Backlighting: None



Keyboard	MSRP	Switch type	Backlight	Rollover	Pass-through ports	Macro support	Onboard memory
Cooler Master MasterKeys Pro L	\$169.99	Cherry MX RGB Blue, Brown, or Red	Yes (16.8 million colors, per-key RGB)	N-key	No	Yes (4 profiles)	Yes (512KB)
Rosewill RK-9000V2 RGB	\$169.99	Cherry MX RGB Blue or Brown	Yes (16.8 million colors, per-key RGB)	N-key	No	Yes (5 profiles)	Yes
Corsair K70 LUX RGB	\$159.99	Cherry MX RGB Blue, Brown, or Red	Yes (16.8 million colors, per-key RGB)	N-key	Yes (1 USB)	Yes	Yes
Rantopad MT Mechanical Gaming Keyboard	\$159.99	Gateron Blue or Black	Yes (white)	N-key	No	No	No
Patriot Viper V770 RGB Mechanical Keyboard	\$149.99	Kailh Red	Yes (16.8 million colors, per-key RGB)	N-key	Yes (1 USB, audio I/O)	Yes (5 profiles, 5 dedicated keys)	Yes (128KB)
AZIO MK Retro	\$109.95	Mechanical Blue	No	N-key	No	No	No
MSI GK-701 Mechanical GAMING Keyboard	\$105.99	Cherry MX Brown	Yes (red)	N-key	No	No	No
Bloody B840	\$99.99	LK Optic Blue	Yes (Neon Glare)	N-key	No	Yes	Yes
GIGABYTE XK700	\$99.99	TTC Red	Yes (16.8 million colors, per-key RGB)	N-key	No	Yes	Yes (512KB)
GIGABYTE Force K85	\$89.99	Kailh Red	Yes (16.8 million color RGB)	N-key	No	No	No
Patriot Viper V730 Mechanical Keyboard	\$79.99	Kailh Brown	Yes (red)	N-key	No	No	No
MSI Interceptor DS4200	\$34.99	Membrane	Yes (multicolor)	20-key	No	No	No



## Use VirtualBox To Try Windows 10

Microsoft has made a compelling argument for PC users to upgrade to Windows 10. As of the Anniversary Update, the OS has officially gotten the equivalent of its first Service Pack. Microsoft's free upgrade offer made upgrading to the new OS cheaper than ever. PC gamers are well aware that they need to be running Win10 to enjoy all the bells and whistles of DirectX 12. And for our part, we've found Microsoft's latest OS to be a step up from Win7 and Win8.1 in terms of UI, performance, and reliability.

There aren't many reasons to resist upgrading, but we won't say there are none. That's why in this month's installment of Software Tips & Projects, we'll walk you through installing Win10 in a virtual machine so you can twiddle its knobs, left-click its icons, and probe its dark corners without the pesky commitment that a typical OS upgrade entails. Win10 is great, but now you don't have to take our word for it; you can see for yourself.

### Prerequisites & Requirements

For the sake of clarity, VirtualBox refers to the computer's native OS (for us, Win7) as the "host," and the one running in the virtual machine will be referred to as the "guest" OS. Before we proceed, you need to find a PC with Win7 or Win8.1 installed that meets Win10's minimum requirements, which include a 1GHz or faster processor, 2GB of RAM, 16GB of storage for the 32-bit OS or 20GB for 64-bit OS, a DirectX 9 or newer graphics card with at least a WDDM 1.0 driver, and a monitor that supports a minimum resolution of 800 x 600.

We'll be using Oracle's free open-source VirtualBox software, which has its own set of minimum requirements. For the processor, Oracle says you need any



Windows 10 feels right at home running in Oracle's VirtualBox.

"reasonably powerful" x86 hardware, so most modern processors from AMD and Intel should do the trick.

One of the biggest limiting factors with running a VM (virtual machine) is not having enough memory. To effectively test the capabilities of Win10 in a virtual environment running on your current Win7 or Win8.1 system, you'll need enough RAM to simultaneously handle both OSes. While it's technically possible to perform this tutorial with just 4GB of RAM, (allocating 2GB each to the host and guest OSes), doing so will provide a less-than-optimal experience, and you may even run into errors or system hangs if you run out of memory. We recommend running at least 8GB of

RAM to avoid creating a bottleneck for either of the OSes, but having more is even better.

The VirtualBox software takes up little room, less than 240MB, so you should be good as long as you have enough room to handle the 16GB or 20GB demands of the 32-bit or 64-bit versions of Win10, respectively. As for VirtualBox's supported operating systems, we're pleased to inform you that Oracle's software works with most versions of Windows, several Linux distributions, Mac OS X, Solaris, and OpenSolaris.

### Get Windows 10

The first step in this multistage process is to simply obtain the Win10 installation

files. Visit [bit.ly/1KwZCCq](http://bit.ly/1KwZCCq) and click the Download Tool Now button, which deposits the MediaCreationTool.exe into your default DOWNLOADS folder. Launch the file, then click Run.

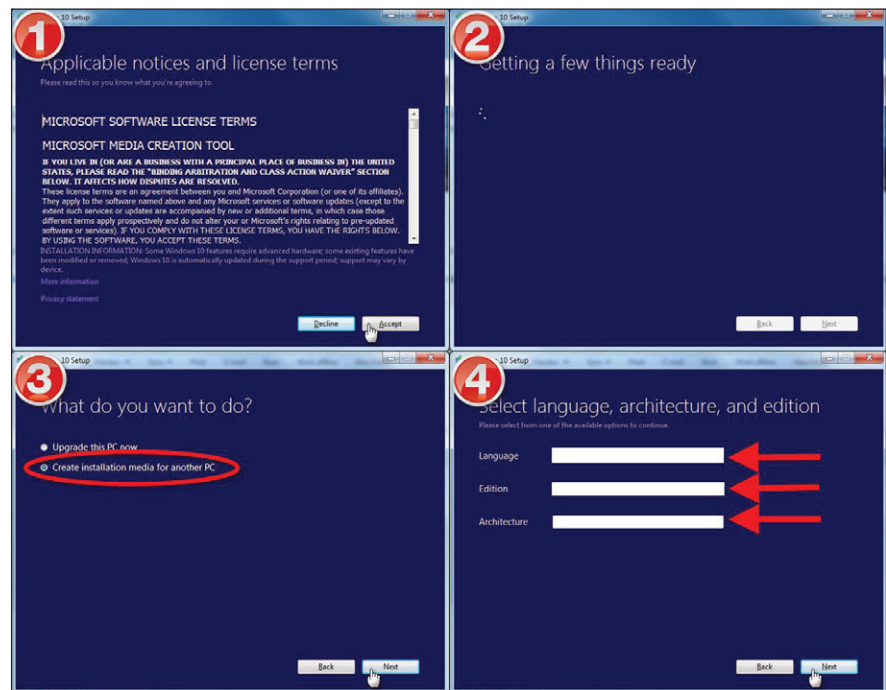
The first screen you see is effectively an end-user license agreement, so click Accept to proceed. Now, click the Create Installation Media For Another PC radio button and click Next. Using the drop-down boxes on the following page, select your preferred Language, Edition, and Architecture (64-bit, 32-bit, or both), and then click Next. Although this procedure won't directly result in you installing Win10 and using your Win7 or Win8.1 license to take advantage of the free upgrade, you may decide that upgrading is worth it, and having already downloaded the appropriate version at this stage will make the upgrade process that much easier.

The following screen lets you opt to download the OS install files and burn them to a USB flash drive (we previously covered this method in our Win10 clean installation tutorial) or as an .ISO file. For this tutorial, we'll be choosing the latter option, so click the ISO File radio button and click Next. Choose a location for the download and then click Save. The files will download quickly as long as you have a reasonably snappy connection. The Windows 10 Setup box will then verify the downloaded files and proceed to create the Windows.iso. All told, the process should take between five and 10 minutes.

There's a hyperlink in the Windows 10 Setup box that launches the DVD Burner utility for creating a disc-based version of the Win10 installer, but VirtualBox can work directly with the .ISO file, so we'll ignore the hyperlink and click Finish. As we went to press, the Windows.iso weighed in at 3.38GB.

## Get VirtualBox

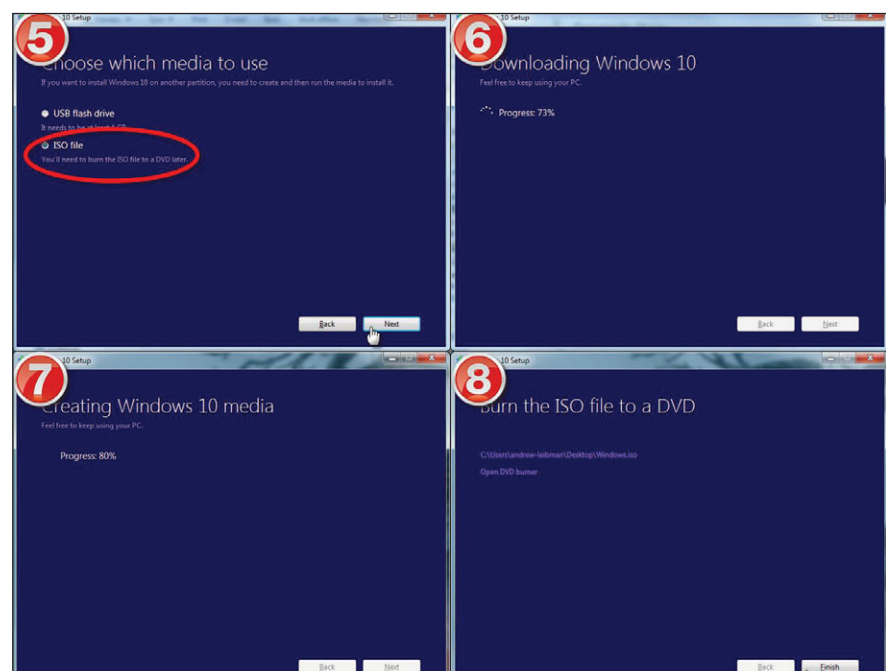
The next step involves downloading and installing VirtualBox. For our tutorial, we're using a Win7-based laptop. Start by directing your web browser of choice to [bit.ly/1nIDA5d](http://bit.ly/1nIDA5d) to see the latest list of VirtualBox downloads. Download VirtualBox (version 5.1.12 at press time)



The procedure for obtaining the Windows 10 .ISO file would be the same if you were planning to perform a clean install of the OS from disc.

by clicking the Windows Hosts hyperlink under the VirtualBox Binaries heading at the top of the page.

When complete, double-click the VirtualBox-5.1.12-112440-Win.exe file and click Run to launch the setup wizard. Click

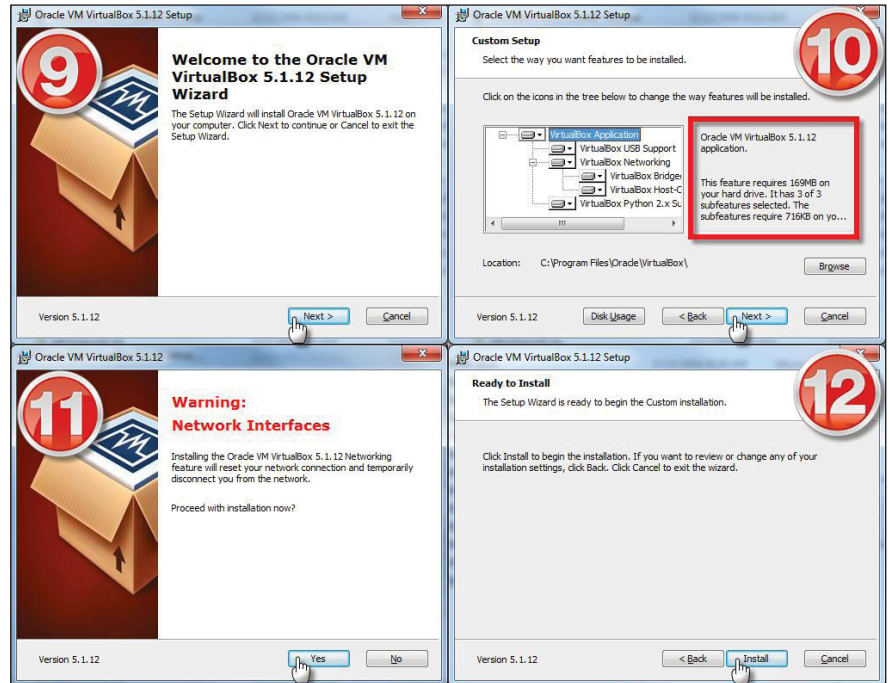


You can skip the part where you burn the .ISO file to disc.



Next to proceed to the installation options screen where the box on the right side of the screen tells you how large the installation will be and how many subfeatures you have selected. From here, you can also change the default install location. Once you've made the appropriate selections and omissions (we won't need Python 2.x support), click Next. The following screen lets you opt in or out of creating shortcuts, a Start menu entry, and registering file associations. We recommend leaving the checkboxes marked and clicking Next. A Network Interfaces warning window appears to inform you that installing VirtualBox's networking feature will reset our current connection and temporarily disconnect the system from the network. Click Yes to proceed and then click Install.

During the process, you'll encounter several Windows Security alerts asking whether you want to install the Oracle Corporation Universal Serial Bus device, network adapter, and network service. Click the Install buttons on these alerts to proceed. After installation, the setup wizard has a checked box that launches Oracle VM VirtualBox, so just click the Finish button to proceed.

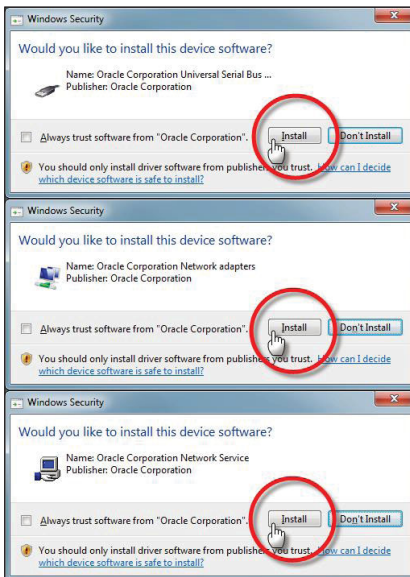


Oracle's VirtualBox software is free, open source, and easy to use.

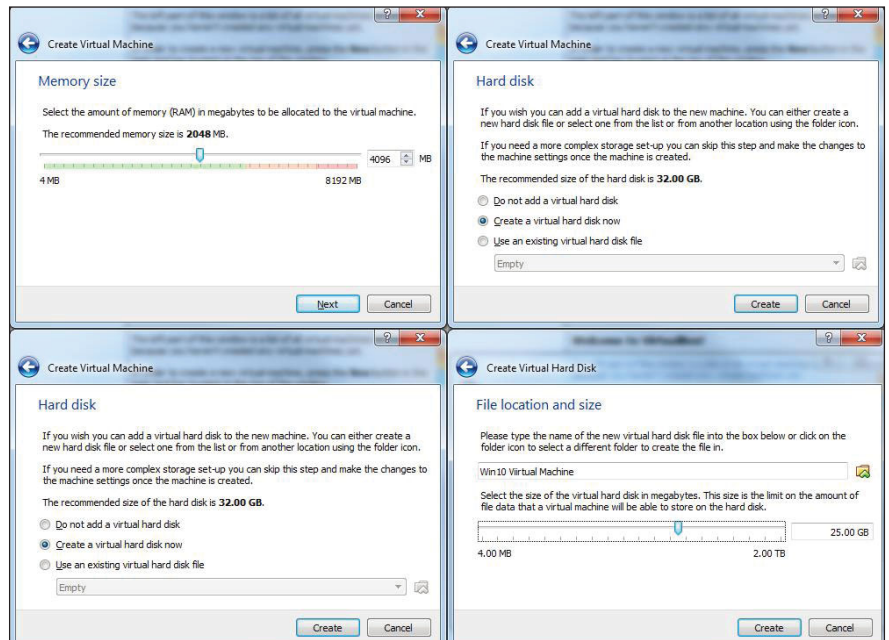
## Unboxing VirtualBox

Upon launch, you'll see the Oracle VM VirtualBox Manager window with a welcome message displayed in the right pane.

Click New from the top left of the window to launch the Create Virtual Machine wizard in guided mode. To begin, give the virtual machine an appropriate name, then use the



Click the Install button three times, or click it once after checking the Always Trust Software From Oracle Corporation checkbox.



The Create Virtual Machine wizard is easy to use, especially in guided mode.

pair of drop-down menus to set the Type to Microsoft Windows and the Version to Windows 10 32-bit or 64-bit, depending on the version of the .ISO file you downloaded.

Click Next to proceed to the memory allocation screen, which features a slider you can drag from as low as 4MB to up to the full amount of memory installed on your system. The bar features green, orange, and red sections, and we recommend sticking to the green ranges to avoid starving your host OS of memory. For our 64-bit version of Win10, 2GB (2,048MB) is the recommended amount. We want our experience to be as optimal as possible, so the more memory you can devote to the VM, the better.

First, we went to the System Tray to get an idea of the background apps running and killed any that we deemed non-critical. Next we clicked CTRL+ALT+DELETE, clicked Start Task Manager, and scanned the items on the Processes tab for any nonessential background applications that consume a lot of memory and killed them. Next we clicked the Performance tab to see just how much of our 8GB of system memory was actually available. We were sitting at 3.31GB used, or about 41%. To play it safe, we used the slider to allocate 4GB to the Windows 10 guest OS, leaving the remaining 4GB to the host OS, then clicked Next.

On the next screen, you're prompted to either create a virtual storage device, use an existing one, or skip this step. For our purposes, click the radio button on the second option, to Create A Virtual Hard Disk Now, then click Create. The next step lets you choose one of three hard disk file types, but the default option, VDI (VirtualBox Disk Image), is sufficient for our purposes, so leave it selected and click Next. Here we have the option to either let the system use a dynamic allocation method for establishing the size of the guest OS's hard disk, or set a fixed size. We'll choose the fixed size option and click Next. When choosing a size, make sure your system storage has enough free capacity to handle the amount you set aside for the guest OS. On the File Location and Size screen, name the virtual hard disk file and set its size to the 25GB before clicking the Create button. This

process can take some time depending on the size and settings you chose.

### Win10 On The VM

Our next task is to install Win10 to the virtual machine using the .ISO file. From the VirtualBox Manager's Settings menu,

click Storage from the list of icons on the left, click the disc icon with the green plus sign at the top right of the Storage Tree box, click Choose Disk from the dialog box, navigate to the Windows.iso file, and then click Open. You can delete the Empty optical drive using the red minus icon just

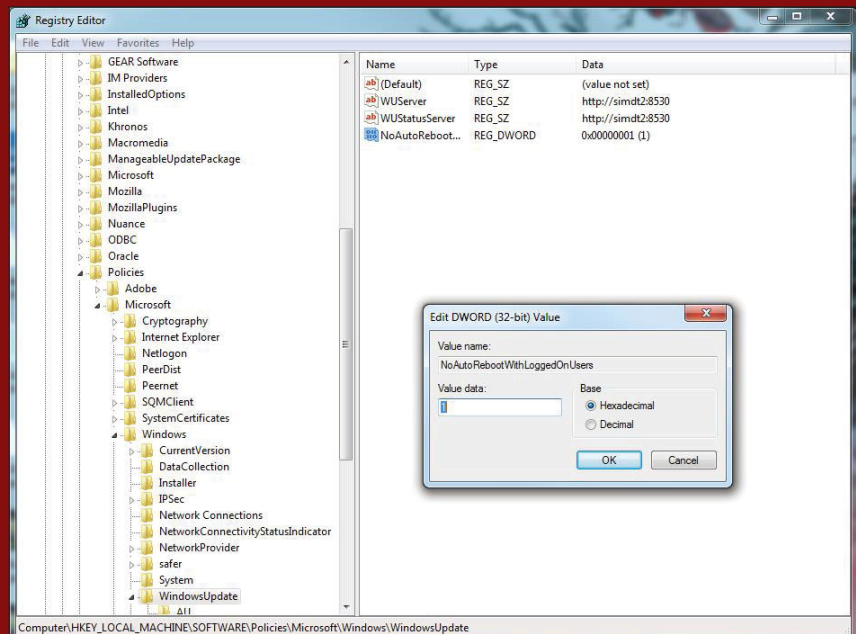
## THROWBACK REGISTRY TIP OF THE MONTH:

### Eliminate Automatic Reboots In Windows 7

Because this month's topic is directed at legacy Microsoft OS users, we thought it would be appropriate to include a Registry edit that caters to Windows 7 users. This one keeps the OS from automatically restarting after installing updates. Win10 users can schedule restarts, so a Registry edit of this type is less useful for them. Incidentally, this tweak also works in Windows XP and Vista, but if you're running one of those OSes, automatic reboots are the least of your problems.

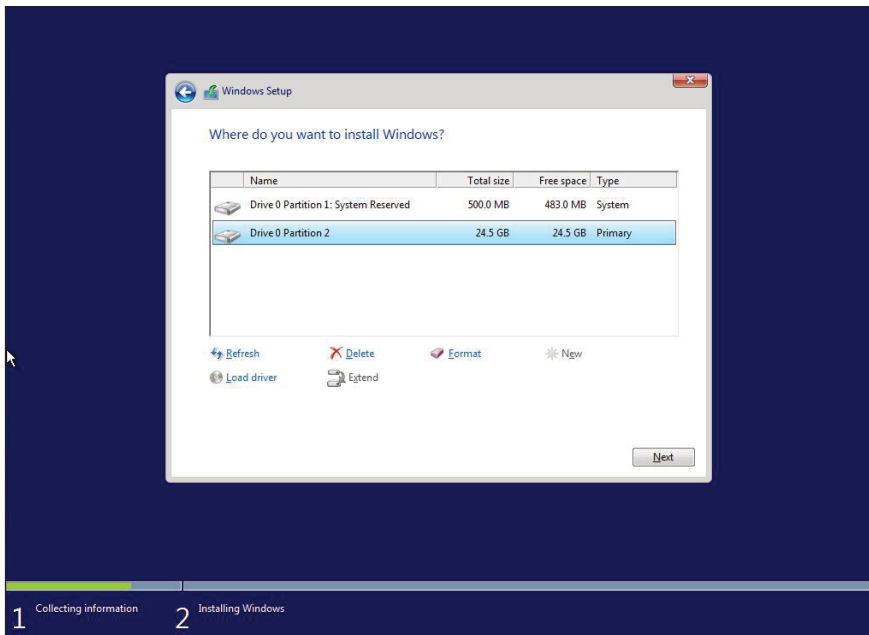
First, click the Start button, click in the search field, type **regedit**, and then press ENTER. Next navigate to HKEY\_LOCAL\_MACHINE, SOFTWARE, POLICIES, MICROSOFT, WINDOWS, WINDOWSUPDATE. If you don't have a WINDOWSUPDATE folder in the WINDOWS folder, we can fix that right now. With Windows selected in the file tree in the left pane, right-click in the right pane and click New, Key, then name the new folder WINDOWSUPDATE and press ENTER.

Next, make sure the WINDOWSUPDATE folder is highlighted in the left pane, then right-click in the right pane and click New, DWORD (32-bit) Value, then name the item NoAutoRebootWithLoggedOnUsers and press ENTER. Double-click the DWORD you just created and type a **1** into the Value Data text box, then click OK. Now all you need to do is log out and log back in, and the tweak will be active.



Windows 7 users sick of automatic reboots will appreciate this quick fix.





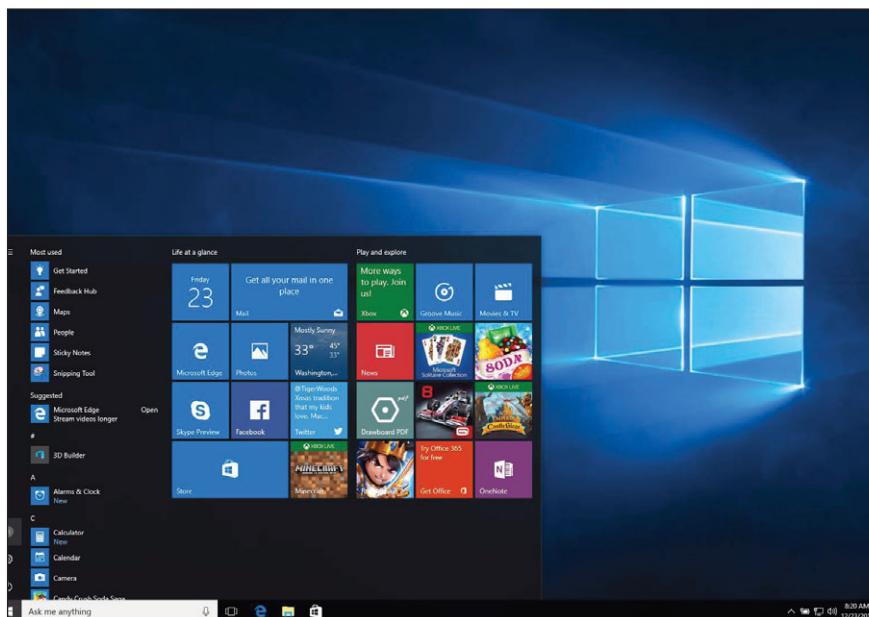
The Windows 10 install process that occurs inside VirtualBox is identical to the real deal.

below the Storage Tree box. Click OK to close the dialog box.

Click the Settings icon again and click Display from the icons menu. Make sure the Video Memory and Monitor Count sliders are both within the green sections of the sliders. You can enable 2D and

3D acceleration, but it's entirely optional. Click OK when you're finished.

Now, it's time to start the VM by clicking the Start button. If you have used VirtualBox before, you may recall an annoying quirk called "mouse capture," which effectively locks the mouse cursor inside of the VM's



When you see the Windows 10 Desktop, that's your cue to start playing around.

window, and only by pressing the right CTRL key can you release the cursor to work with other applications. In this instance, however, Win10 supports a feature called Mouse Pointer Integration, which lets us seamlessly jump between the VirtualBox window and other applications without having to press a special hotkey.

If you've installed a Microsoft OS from an ISO or Flash drive recently, then the Windows Setup screen will look familiar. As the installation begins, you'll be prompted to type in a license key, but you can click the I Don't Have A Product Key hyperlink to bypass this process for the time being and proceed directly to the version select screen. Choose the version you want to install, click Next, click the I Accept The License Terms checkbox on the EULA screen, click Next again, and then click the Custom: Install Windows Only (Advanced) option.

The storage selection screen will display the unallocated space you set aside during the VirtualBox setup process, so select it, click New, then click Next. From here on, you just need to follow the on-screen prompts to complete the Win10 installation process. Having installed Win10 numerous times on more than a dozen devices, we can tell you that the VirtualBox install process is identical to what you'd experience if you were performing a clean install of the new OS.

Once the OS is installed, you can simply click Start to promptly boot into Win10. Click View from the menu bar at the top of the VirtualBox window and click Full-Screen Mode, then right-click the Win10 Desktop background, click Display Settings, click Advanced Display Settings, and then set the resolution to your monitor's native resolution.

## OS Inception

We know what you're thinking, but if you plan to install VirtualBox inside your virtualized Win10 machine to run Ubuntu, then you're going to need a lot more memory. All jokes aside, if you want to really dig deep, check out the numerous Software Tips & Projects articles we've written over the past year and a half to make Microsoft's latest offering the most power-user-friendly platform ever. ■

# Upgrades That'll Keep You Humming Along

A pair of high-powered remote desktop programs lead off our latest batch of software updates. Also, you can use Geo Firewall to shore up your defenses and Nimbus Note to keep your busy power user life organized. Last but definitely not least, AMD has a new software suite for Radeon owners.

## SOFTWARE UPDATES

### AnyDesk 3.0

AnyDesk relies on a proprietary video codec to give it a leg up on the competition; the software laughs in the face of low frame rates and high latency. An integrated address book is the marquee feature in AnyDesk 3.0. The new address book is admittedly geared toward AnyDesk Pro users (read: IT staff at SMBs), but those who take advantage of the feature should be delighted with its power. Using a new hierarchical tagging system, users managing large numbers of systems can create groups and quickly search them to pinpoint machines they need to remotely access. AnyDesk 3.0's interface receives a new coat of polish, too; the slicker UI should be a good match for Windows 10 systems.

<https://anydesk.com/remote-desktop>

### Devolutions Remote Desktop Manager Enterprise Edition 12.0.5.0

For some power users, a basic PC-to-PC remote desktop app will get the job done. For bigger jobs, you need a command center. Remote Desktop Manager is definitely the latter. Like AnyDesk Pro, Remote Desktop Manager is also built for SMBs and enterprises, which can put the program's power to use. Although the latest version introduces a pair of minor improvements (MySQL support for role-based security and a User Interface option in Contact/Data Entry/Document), the 12.0.0.0 release at the end of November 2016 was jam-packed with new features, such as HyperV and VMWare synchronizers, a new PowerShell module, and a new root connection.

<https://remotedesktopmanager.com>

### Nimbus Web Nimbus Note 2.0.7

If you've waited this long to jump on the note-taking software train, why not give Nimbus Note a try? You can take basic notes and then spruce them up with tables, images, and bulleted lists. Nimbus Note can also make to-do lists and save webpages. Tagging is the main focus of the latest version for PC. A new tag panel makes adding tags in Nimbus Note "more simple and convenient," according to the developer. In addition to the revamped tag panel, version 2.0.7 squashes bugs and improves performance when inserting images into notes.

<https://nimbus.everhelper.me>

### Registry Finder 2.15

Despite its name, Registry Finder does a lot more than dig through your Registry in search of this or that key. The handy little tool also doubles as an editor, and you can do your editing within the program's Find Results pane. In version 2.15, Registry Finder learns a handful of new tricks. Now, you can use regular expressions with the Search and Replace operations, and the Replace command will replace every instance of a matched substring, rather than only the first. A new command line parameter, "--newTab," opens a new tab, unsurprisingly, and now double-clicking the address bar outside of a tab opens a new local Registry tab.

[registry-finder.com](http://registry-finder.com)

### Symless Synergy 1.8.6

Synergy lets you use a single mouse and keyboard across multiple systems regardless of operating system (Windows, Mac OS X, and Linux, that is). You won't find any shiny new features with this latest update,

but a handful of important bugfixes will keep Synergy running smoothly. For instance, prior to the update, a malformed serial key in the Registry would crash Synergy's GUI on startup, and the software was unable to recognize certain keys when running on Mac OS X Sierra clients.

<https://symless.com>

### Verigio Communications Geo Firewall 2.7

With so many web servers located in countries with "relaxed" internet security laws, all it takes is one redirect to infect your computer with malware. Wouldn't it be great to simply block connections to countries with shaky internet security track records? Cue Geo Firewall, which does just that. The latest version lets you create user-defined networks. Also, Verigio Communications has switched Geo Firewall's data file format to XML. Version 2.7 also gives users the option to start Geo Firewall in the System Tray.

<https://www.verigio.com>

## SOFTWARE UPDATES

### AMD Radeon Software Crimson ReLive Edition 16.12.1

This massive new software suite rewards AMD partisans for their loyalty. Radeon ReLive, the titular feature, lets gamers record their gameplay, stream directly to Twitch and YouTube, and more. Radeon Chill is able to dial down the frame rate to save power if the software determines your in-game action isn't very demanding. AMD has baked in plenty of other goodies for a bunch of Radeon graphics cards, so check it out.

[support.amd.com](http://support.amd.com)



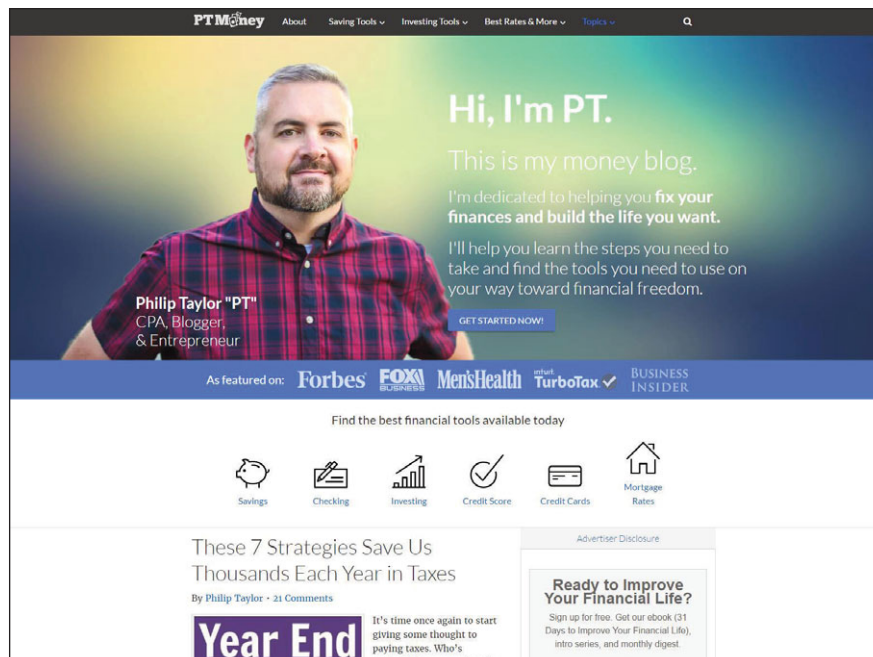
# Finance & Technology

## FinTech Tools For Investing & Personal Finances Abound

Taking control of personal finances and investing for a better financial future is something most people know is important. Many, though, never take the first step. Gallup data from 2016, in fact, shows only 52% of U.S. citizens are investing in stocks, including as part of their retirement funds. That compares to the roughly 65% of all Americans and nearly 75% of middle-class Americans who reportedly invested in stocks in 2007. Today, Gallup reports only 50% of middle-class Americans own investments.

A 2016 Bankrate.com survey shows similarly bleak conditions, particularly among millennials, with only a third reportedly owning stock. The reasons why people aren't investing are pretty straightforward. In a 2015 survey, for example, Bankrate.com found 53% of those questioned reported they simply don't have the money, while 21% reported they lack investment knowledge, 9% don't trust stockbrokers, and 7% believe stocks are too risky. The good news is that financial experts seem to agree that with some sacrifice and learning, options exist to both get started in investing and improve personal financial situations. Seemingly every financial guru also agrees the time to act is now, as every day without action is another day of potential earnings wasted.

Historically, investing generally meant paying a stockbroker or financial advisor significant fees and/or commissions to buy and sell on your behalf and provide personalized advice. Around the mid-1990s, though, the internet helped foster the ability for individuals to invest for themselves online. Today, dozens of brokerages provide online trading platforms to buy and sell securities at discounted fees and commissions compared to traditional brokers or



The internet has many blogs, websites, YouTube channels, and other outlets from various financial advisors, stockbrokers, personal finance gurus, and other financial experts who offer practical investing and money-management advice. PT Money, which Philip "PT" Taylor founded in 2007, is one popular example.

advisors. While you'll receive little to no personalized advice, nearly every platform offers at least some tools, research, and data to help make informed decisions. Many platforms also specifically cater to investment novices via free accounts, no minimum investment limits, and simplified approaches. Robo-advisors, for example, essentially automate the process through algorithm-based approaches.

In addition to online investing, the internet helped bring about a wealth of free accessible financial research, data, and advice, including from governmental and regulatory bodies that help investors investigate brokers and potential investments and from hundreds of websites, blogs, YouTube channels, forums, and other outlets diving into

mutual funds, 401(k)s, credit card debt, earnings potential, trading securities, and more. Notably, many of these outlets stem from people who themselves were once in dire financial straits.

"Technology is no longer a luxury for only a select few investors; it's available to all investors and has made it easier to get started," says Alex Rupert, an assistant portfolio manager and contributor at Investopedia.com. "The internet has also increased the speed of trading, giving some skilled traders who have more advanced technology a leg up."

Philip "PT" Taylor, founder of the PT Money blog, sees huge potential in newer fintech (financial technology). "The more technology can be leveraged to help us overcome our own

destructive natural human behaviors, the better,” he says.

Arguably, there are so many financial-related resources available online today that it’s intimidating for beginners to know where to start to change their financial situation. While it’s vital that any investor or someone making changes does her own research and works with trusted parties, the following offers advice to get started in online investing and better managing personal finances.

### It Makes Good Cents

Much advice regarding online investing and personal finances stresses the importance of defining financial goals, doing the requisite research, and learning key financial terms to help navigate the financial waters you’ll encounter. Seemingly every financial expert also advises beginning by saving whatever you can starting immediately. Beyond helping create an emergency fund (the equivalent of six months’ salary is the general advice), Investopedia.com states that accumulating savings broadens your financial options, including the ability to start investing and putting your money to work for you over the long haul.

Getting started in online investing can take just \$50 or less, but Rupert cautions that a big mistake seasoned and novice investors make is investing money they can’t afford to lose or investing in a manner not aligning with personal goals. “If you’re investing in a speculative manner, you have to be prepared to lose some or all of your investment,” he says. Sam Dogen, founder of the Financial Samurai blog, says that if what “you’re saving each month doesn’t hurt, you aren’t saving enough.” The sacrifice is “absolutely worth it,” he adds. Dogen himself lost 35% of his net worth in the 2008 financial crisis, only to recover and retire in his 30s a few years later. Today, technology is making it easier to oversee finances and help people save, he says. “Before, it was hard to track. Now, technology makes things easier,” he says.

Taylor consistently recommends automating and separating your savings.

“Set it up and forget about it,” he explains. First, ask your employer to split your paycheck into different percentages for direct deposit into separate bank, 401(k), and IRA accounts, he says. If this isn’t possible, direct deposit the entire

check and set up automatic withdrawals from there to the various accounts. The general idea is to make savings hard to tap into by “setting up an imaginary wall between you and your savings accounts,” says Taylor, who specifically advises using

## 10 Terms Of The Trade

The investment and financial space has a seemingly infinite list of terms unique to that world. Fortunately, financial dictionaries are plentiful online. InvestorWords.com, for example, houses 15,000 definitions for financial-related terms. Based on numerous such dictionaries, the following are 10 financial terms novices will eventually encounter.

**Bear and bull markets.** Both terms can apply to essentially anything that’s traded. “Bear” signifies falling prices, while “bull” means the opposite. Further, investors can be “bearish” or “bullish” on specific stocks and companies. Remember, bulls jut their horns up, and bears swipe their claws downward.

**Blue chip.** “Blue chippers” are typically larger, well-established companies regarded for their consistently solid performances in terms of their earnings and paying out dividends to stockholders.

**Bonds.** Investing in bonds essentially means loaning money to a company, government (think Treasury bonds), or other party that in turn promises to pay back the principal and interest. Buying bonds is generally considered a safe but low-return investment.

**Broker.** Someone who buys and sells investments for an investor for a fee or commission and also provides personalized investment advice. Online brokerages that provide investors with online trading platforms to buy and sell through carry lower fees but typically offer far less personalized advice.

**Capital gain.** The difference between what you buy an investment at and what it sells for is the capital gain (or loss). If buying a stock at \$10 per share and selling it at \$15, the capital gain is \$5 per share.

**Dividend.** Earnings a company makes and then distributes to shareholders.

**Exchange.** The marketplace or platform used by buyers and sellers to trade financial stocks, commodities, bonds, and other financial assets. The New York Stock Exchange is one of several exchanges.

**Margin.** Money an investor can borrow from his brokerage firm to buy bonds, stocks, or other securities. Typically, cash and/or securities in the customer’s account is used as collateral.

**Mutual fund.** Rather than buy shares individually, a mutual fund enables investing in a portfolio of assets (typically various stocks, bonds, and other investments) overseen by a professional portfolio manager.

**Stock.** A small slice of ownership. Buying stock in a company essentially means you own a fraction of the company. As the company’s performance goes, so too goes the stock’s value.



401(k) and IRA accounts for retirement savings. He also advises using online-only savings accounts such as FNBO Direct or Capital One 360 for short-term savings goals. "These accounts don't come with a debit or credit card, and transfers from these accounts to your other bank account take a few days, lessening the chance that you'll tap into them readily."

Even with savings in place, fear will keep many people from trying their hands at online investing. "Not knowing how to start investing, a new investor will imagine it will be complex and shy away from starting out," says Richard Smith, a contributor to The Motley Fool. Once committed, though, most people discover this isn't nearly the case, he says. "Remember, online brokers want you to invest your money with them. To facilitate that, they're going to make setting up an account as easy as possible," he says.

Smith recommends initially just opening an account with an online brokerage and putting money in it. "Sit and watch it for a few weeks. Only after you feel comfortable with the account 'being there' should you begin using it," he says. "Buy a few shares of the S&P 500 index or an ETF [exchange-traded fund] representing it. Watch it grow in value over time. Watch it outperform the rest of the account, which is just earning interest at money market fund rates. Then, buy a stock or three. Compare how they perform relative to the S&P 500 index. Take it slow, and build up your confidence."

Beyond accumulating savings, compiling a core set of go-to financial resources for guidance, research, and data is also key for beginners. Taylor, for example, advises using RockstarFinance.com for personal finance information and Bogleheads.org's forums for investing information. In addition to his own FinancialMentor.com website, financial advisor Todd Tresidder recommends MrMoneyMustache.com for its frugality-based information. Tresidder also recommends "Think and Grow Rich," a "must-read classic" he'll read to

## A Word Of Warning: Know The Risks

As Richard Smith, a contributor at The Motley Fool, says, the "information-everywhere" dream that investors once had is now reality. "From easy access to SEC [Securities and Exchange Commission] filings via EDGAR [Electronic Data Gathering, Analysis, and Retrieval] to free data aggregators like Morningstar to free online screeners such as Finviz.com, it's become a whole lot easier for investors to know what they're buying these days," Smith says.

Unfortunately, technology has also made it easy for nefarious parties to run scams on investors, particularly beginners. Examples include so-called "pump-and-dump" schemes and other stock-manipulation attempts that basically involve a scammer deliberately spreading misleading or false information about a security to get investors to bite on it to raise or lower its price.

The Federal Trade Commission provides various advice at its site concerning scams, risks, and other issues associated with online investing. Chief among its advice is the importance of recognizing that any investment opportunity promising "low risk and high reward" is nearly always a fraud. The FTC recommends conducting research through such unbiased sources as the SEC; state securities regulators; and such self-regulatory organizations as FINRA, AMEX, and NASDAQ. "Never ever invest based solely on what you read in an online newsletter, bulletin board posting, or blog," the FTC warns. In general, beware of companies that make grandiose claims concerning their new product developments, lucrative contracts, and financial health, the FTC cautions.

Money-making investing schemes commonly entail multilevel marketing efforts (think pyramid schemes), business-opportunity promises, seminars that tout business and investment opportunities, internet startups; investments in gold, collectible coins, and bullion; government grant scams (or "money for nothing" offers); and false and bloated claims about an invention's potential.

Like Smith, the FTC recommends using EDGAR to investigate potential investments. To sell securities legally, sellers must register with the SEC or qualify for an exemption. Consulting EDGAR can help in situations when a fraudulent seller may claim to be SEC-registered and even provide a contact person to verify it. The contact, however, is in on the scam. A free BrokerCheck tool at FINRA's website lets you check brokers/brokerage firms concerning various investments. Among other information, BrokerCheck can help ID brokers who are no longer registered to trade securities but still work in the industry. "These individuals could still seek to gain the trust of potential investors," FINRA states.

Item	Form	Description	Filing Date	Filing Size
10-K	10-K	Annual Report of CRR, 001554408 (see all company filings)	2014-03-26	1,111,111
10-Q	10-Q	Quarterly Report of CRR, 001554408 (see all company filings)	2014-03-26	1,111,111
10-Q	10-Q	Quarterly Report of CRR, 001554408 (see all company filings)	2014-03-26	1,111,111
10-Q	10-Q	Quarterly Report of CRR, 001554408 (see all company filings)	2014-03-26	1,111,111
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10-Q	10-Q	Quarterly Report of CRR, 001554408 (see all company filings)	2014-03-26	1,111,111
10-Q	10-Q	Quarterly Report of CRR, 001554408 (see all company filings)	2014-03-26	1,111,111

The EDGAR (Electronic Data Gathering, Analysis, and Retrieval) system from the SEC lets investors research various companies and investments they're interested in, in part by looking through filings and disclosures made by companies.

Other FTC advice includes knowing where securities are traded. Those traded via "over-the-counter" markets, for example, are among the most risky and prone to manipulation. Also be skeptical of pushy investment pitches that promise a big return if acting soon. Additionally, upon receiving a hot stock tip, ask how the tipper will benefit if you do invest. If you encounter someone or something worth pointing out, use the SEC's Online Complaint Center.

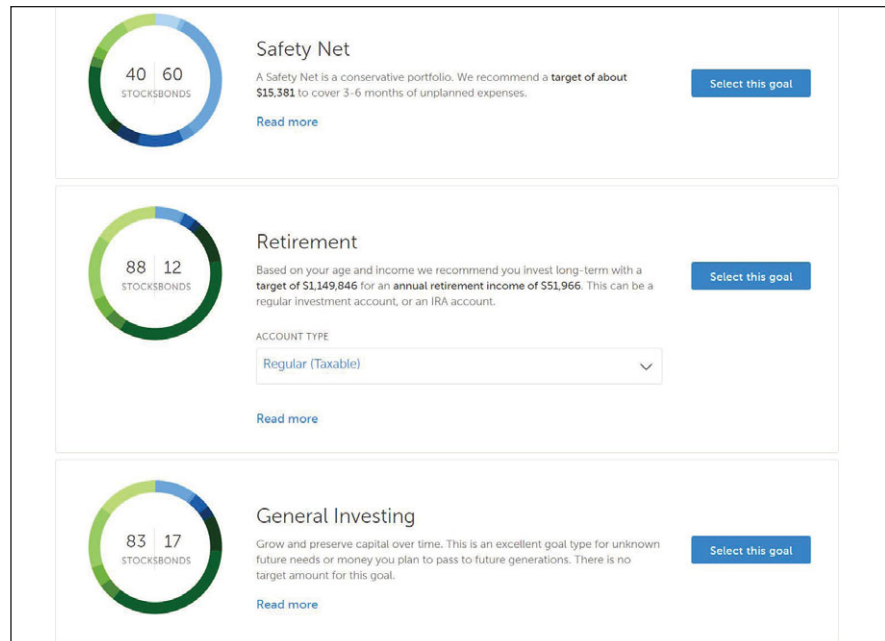
his children one day because “it’s that good.” Similarly, Dogen advises reading about personal finances but from those who’ve actually studied and worked in the field and who’ve gained financial independence. “Your finances are too important to be left up to pontification,” he says.

Also key to remember when starting out is that all the fintech and online information in the world can’t overcome poor personal financial habits. As Tresidder says, “investing and personal finance existed long before technology, and the principles that result in success have nothing to do with technology. Technology only changes the administration of a well-thought-out financial process and lowers the cost.”

### Online Investing ABCs

Even when standing on solid ground to begin investing online, many people will question if they should. Taylor believes everyone should at least consider it. “Whether you’re growing your wealth or preserving it, online investing tools make it easy and safe,” he says. Conversely, most people shouldn’t consider engaging in active trading with a majority of their portfolio, he says. “History has shown that humans are really bad at trying to beat the basic market returns. Invest for the long haul using diversified, low-cost funds inside tax-advantaged accounts,” he says.

Taylor’s advice touches on an important distinction anyone interested in investing must understand: the difference between “investing” and “trading.” As Smith says, one “invests” in businesses but “trades” stocks, with stocks essentially equating to fractional shares of a company. “The longer your time horizon, the more a serious investor should gravitate toward investing in businesses rather than merely trading into and out of stock tickers,” he says, adding that data proves stock market investments generate the greatest returns long-term. “Accordingly, I think everyone should consider online investing. Over long periods of time, it’s the best way to build



Robo-advisors represent a newer investment option that has grown in popularity in recent years. Financial website NerdWallet describes a robo-advisor as “an online financial advisory firm that leverages automation and algorithms to help manage client portfolios.” The automation aspect enables such providers as Betterment to “offer investment management services to consumers for a fraction of the cost of a human financial advisor.”

wealth. I view trading as more akin to gambling,” he says.

As Rupert explains, investing is an attempt to profit from a company’s long-term growth and prosperity, while trading is an attempt to profit from short-term fluctuations or opportunities regarding specific securities (stocks, bonds, mutual funds, etc.). If trading entices you, expect to spend considerable time learning to spot the fluctuations and opportunities Rupert mentions. Also know that while trading can generally bring greater financial reward, the risks are greater. Sometimes, Rupert says, a “get rich fast” trading mindset results in people “ready to swing for the fences without realizing they’re playing chess.”

Eventually, beginning online investors will need to select an online trading platform, of which there are dozens from such online brokerages as TD Ameritrade, E-Trade, OptionsHouse, and Fidelity. As part of a comprehensive guide of online brokers, The Simple Dollar advises that

seeking a few key traits can help mitigate stress related to managing your own money. These include low fees; ensuring the online platform has a clean interface and intuitive access to balances, available cash, and other pertinent information; and quick access to basic charts concerning the historical performance of securities.

As The Simple Dollar also notes, many online brokerages offer capabilities that stretch beyond trading securities to essentially make them “full-fledged trading, saving, investing, retirement planning, and banking machines.” A standout platform will provide quality trading tools and technology, different trading platforms for different levels of traders, excellent mobile trading features, and solid educational resources and research, The Simple Dollar writes.

Another key to selecting an online trading platform is ensuring you understand the brokerage’s fees. “Finance has a habit of making things harder to



## The Gaming Way To Learn How To Invest

If you're a millennial and aren't investing, you're hardly alone. Various studies indicate 20% or fewer have done so for reasons such as a lack of money to get started. Several newer companies, however, could change this lack of participation by appealing to millennials with features they're comfortable with, including social-network-like communication, mobile apps, and gaming-centric approaches.

Invstr, for example, states a mission to "make finance social by democratizing access to information and empowering everyone to take charge of their financial future." Scutify, meanwhile, claims to be the most innovative social network for investors, traders, or those new to the markets. The company offers a Hedge Fund Manager game that lets players compete against other "Scutifiers" and "Scutify All-Stars."

Kapital also recognizes that investing can be confusing and intimidating. Given everything younger generations can spend money on, Kapital states, it makes sense they aren't investing as much as older generations. This doesn't mean younger generations don't care about their futures, "it just means preparing for retirement may not be the most important decision" on their plates. To steer them in a different direction, Kapital uses a gaming-centric approach to investing, which is appropriate considering co-founder Gaspard de Dreuz was a former console and PC game developer. Co-founder Serge Kreiker, meanwhile, previously developed tools for Bloomberg's trading system. Launched in 2012, Kapital provides users ("Kapitalists") a free account to acquire \$100,000 in virtual currency to use toward building investing skills via a Practice Portfolio.



Kapital is one of several services that use a gaming-style approach to help people learn about and get familiar with online investing before making actual investments, which users can also do through Kapital.

Kapital's other nods to gaming include Koins (or virtual currency) that users accrue by performing various tasks such as sharing information with other Kapitalists, playing investing-oriented games, leveling up, and exploring Kapital's website. Users can use those Koins to buy actual merchandise in the Kapital Store. Elsewhere, Kapitalists can acquire Tournament Portfolios and virtual currency to compete against others in monthly competitions for actual cash, and when a Kapitalist feels confident enough to make actual investments, she can via a Live Portfolio feature, with Kapital making a \$7.95 commission per trade.

BUX, which claims 500,000 registered users, states that while the stock market essentially amounts to the "biggest and best game on Earth," trading still remains inaccessible to many people often because investing is seen as too complicated, boring, and expensive. Thus, BUX's mission is to make "stock trading exciting for everyone."

To help reduce complexity and confusion, Kapital takes such measures as displaying a tradeable company's logo vs. its often more confusing ticker symbol. Additionally, numerous functions are drag-and-drop easy, including making investments from the platform's Playground area.

understand than they actually have to be," Rupert says. Smith says the several platforms he's used over the years have all been perfectly acceptable. Initially, he advises selecting one that offers the best prices and incentives to open an account, and over time, don't be afraid to switch providers to take advantage of new incentives. "There's a learning curve to figuring out precisely how each platform works, but it's not particularly steep," he says. Similarly, Tresidder says online trading platforms have become a competitive, commodity service. "All

the major players are good. Focus your energy on the investment process, not the investment platform," he says.

A newer investment option to consider is using a "robo-advisor," which one source described as making "investment management available to the masses." Typically featuring low account minimums and intuitive interfaces, robo-advisors generally use algorithms to automate investing. Betterment is often cited for its robo-advisor approach. It claims it's using technology to make "what has worked for decades" with

investing more efficient to save users time and increase their after-tax returns. Essentially, Betterment uses an investor's personal financial situation and goals to make recommendations and automate various investment and management tasks "in a way that many traditional investment services can't," it states.

"Robo-advisors are good for investors looking to get started but don't have a strong interest in learning about and understanding investing," says Rupert, who adds that more intricate personal-financial situations likely do

require input from a seasoned financial professional. Most robo-advisors, he says, currently only focus on creating low-cost portfolios with an emphasis on asset allocation. Dogen also sees robo-advisors as making a real difference for people uncertain of where to start and those who don't want to pay traditional advisor fees. "If you had started investing with a robo-advisor in 2012, your equities would be up close to 60% by now vs. little gains holding in cash," he says.

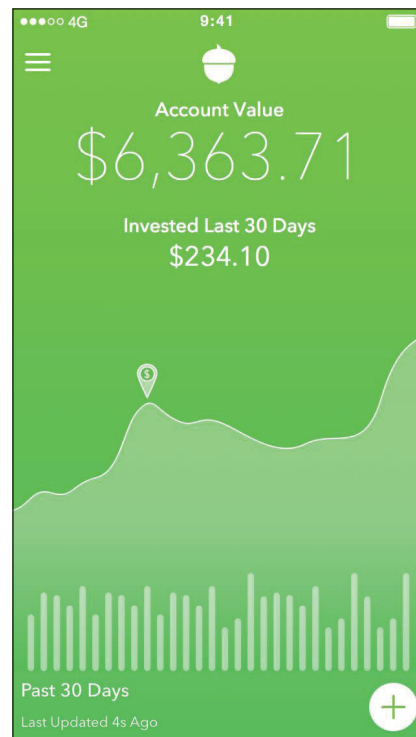
### Tools Of The Trade

Whether you're interested in investing or getting a better grasp on your personal financial situation, an ever-growing list of tech tools, including mobile apps and online services, are available to provide assistance. As Tresidder notes, though, it's important to remember that investing and personal finance have been around much longer than technology. The principles that result in success have nothing to do with technology, Tresidder says. "Technology only changes the administration of a well-thought-out financial process and lowers the cost."

Dogen makes an important point that while someone with the interest, time, and patience to learn how to invest, allocate assets, and watch their money can do everything a financial advisor can do, many people lack these traits. Thus, he recommends seeking a fee-only financial advisor to help get started vs. a financial advisor who will charge 1 to 3% of your assets being managed. Dogen provides a free "Do It Yourself Investment Checkup Guide" to help. "If you can't figure it out or are still uncomfortable with the process, then it may be a good idea to speak to a professional," he says.

For those determined to try online investing but want to gain some experience first, some experts recommend using an investment simulator, which provides virtual currency to practice with before making actual investments. Investopedia.com, for example, has a stock market game that provides \$100,000 in virtual currency. Overall, simulators typically

present actual investing elements to help prepare you, including charging broker fees and commissions, which Investopedia.com notes can significantly impact an investor's bottom line. As a veteran investor, Smith tends to use simulators ("I'm partial to caps.fool.com, of course") "more as a shopping list of ideas that I can refer back to when deciding which stock to buy next," he says.



Acorns claims more than 1 million have used its service, which is billed as a "micro" investing platform. Upon connecting bank accounts and cards to the service, Acorns rounds up normal purchases you make to the nearest dollar, automatically investing the spare change.

Rupert cautions that simulators can be a scary precursor to actually investing, as most simulators provide users large sums of virtual money (even \$1 million). "This isn't realistic for most investors looking to use a simulator to test the waters," he says. "You won't find all the emotions of investing while using a simulator—it isn't real money. This is important because behavioral finance is a critical concept for investors to be aware of that

can cloud your mind and alter decision-making skills."

Outside of simulators, other fintech tools to explore include scores of mobile apps, many of which provide convenient and powerful capabilities. Smith tabs Robinhood, for example, as "pretty nice little app for basic investing." Offering free trades, Robinhood is regarded as being well-suited for newer investors and for doing away with expenses other brokerages charge. Stash Invest is another app geared toward millennials. It's a micro robo-advisor that uses a "start small, think big" approach that enables investing for as little as \$5 in an effort to encourage users to learn and grow into bigger investments.

Other web- and app-based services commonly cited for their quality are FinMason, which helps investors measure their risk tolerance; Morningstar, which offers a wealth of current investment-related information; Acorns, which connects to a user's financial accounts and cards to round up normal purchases to the nearest dollar and automatically invest that "spare change"; Digit, a similar service that uses small amounts of spare money to grow wealth; Wealthfront, a robo-advisor that is well-regarded for its investment-management capabilities; YNAB (You Need A Budget), which helps improve budgeting skills; Mint, a free budgeting and management service; EveryDollar, which aims to put all your dollars to work; GnuCash, personal budgeting software that supports numerous OSes, including Linux; and Personal Capital, which helps manage a user's financial portfolio and provides investment guidance.

In addition to those services, there are many investment, budgeting, money management, and other personal finance blogs and educational resources, including Yahoo! Finance, CNN Money, Get Rich Slowly, FiveCentNickel, The Reformed Broker, NerdWallet, Financial Ducks In A Row, Investor Junkie, Oblivious Investor, Cash Cow Couple, Dough Roller, Good Financial Cents, Money Crashers, Debt Roundup, Money Under 30, Wise Bread, and AllFinancialMatters. ■



CPU

Game Of The Month

Yeah, we know you have blogs to post, video to encode, reports to write, and code to compile. We do, too, but you have to take a break once in a while (and maybe blow some stuff up). That's why each month we give you the lowdown on what to expect from the latest interesting games.

# CALL OF DUTY INFINITE WARFARE

My last doorway to the Call of Duty world opened a year ago with the launch of Call of Duty: Black Ops III, and in addition to being blown away by that game (pun intended), I wondered how Activision could live up to the ridiculously high bar it had set. Call of Duty: Infinite Warfare is the answer to this question, and it doesn't just raise the bar—it launches that bar into the sun.

Infinite Warfare is digital nirvana for fans of sci-fi- and military-themed shooters for lots of reasons, including amazing visuals and sound effects, multiplayer that is quite possibly the pinnacle of the genre, the best CoD campaign ever, a cool Zombies sub-game, and a metric ton of cool features and options. In truth, there's so much to do and see in this game that it's almost paralyzing; in preparing for this review, I wanted very badly to play online multiplayer and I wanted to play the campaign, but I only have two hands and one brain stem.

Of course, multiplayer is what drives Call of Duty games and keeps millions of people playing each game all year until a new one comes along, and Infinite Warfare will be no different. The levels are huge and highly detailed, the action is fast and insanely fun, and the customization and player progression systems are so engrossing that you will at some point actually find yourself getting mad that the next match is starting because you're having that much fun messing around with loadouts and personalization stuff.



## Call Of Duty In Space

BY CHRIS TRUMBLE

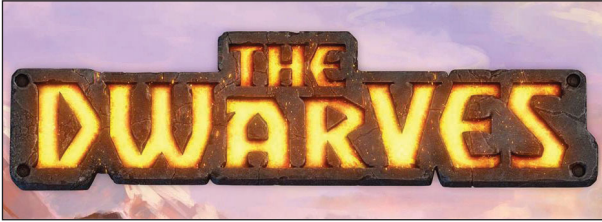
\$59.99 (PC, XOne, PS4) • ESRB: (M)ature  
Activision • [www.callofduty.com](http://www.callofduty.com)

But don't forget to play this campaign. Infinity Ward really pulled out all the stops on it, and it's the polar opposite of the brief, almost perfunctory campaigns that used to accompany CoD titles. The story is really cool, and although it relies on a fairly silly conceit to do so, it gives you pretty much everything you could ask for as a player. Your character, a spec ops fighter pilot named Nick Reyes, is both an accomplished commando and a crack fighter pilot, and after the game kicks off with a dramatic attack by the villainous SDF (Settlement Defense Front), also becomes the acting captain of a space carrier named Retribution.

Obviously, even in a time of war and up against drastic circumstances, no one person would ever attempt to (or be allowed to) fill all of those roles, but as it turns out, taking the story in this direction was a stroke of genius. You get to play excellent FPS missions and very good fighter combat missions, and you get to take command of a massive, futuristic warship and choose what missions you play and when.

As the first CoD game to slip the surly bonds of Earth, Infinite Warfare lets you do it all, and in the process makes it very easy to work in futuristic weapons, cool AI characters, and hot shooter stuff like wall running and such, all without straining the narrative a bit. This game is a must-own for sci-fi shooter fans. ■





In many great works of fantasy, storytelling is an integral part of the story. Whether it's the world-weary bard singing tales of his travels in a seedy inn at the edge of the world or the centuries-old high priestess passing down ancient mysteries to a promising acolyte, legend and lore help shape the Westeroses and Middle Earths we love so much. So, our review of THQ Nordic's *The Dwarves* begins with a story.

Strange as it might seem, *The Dwarves* has a couple of things in common with a game it ought to have precisely zero shared attributes: *Metro 2033*. Both games are THQ properties, and both are based on



novels from Eurasian authors. Russian writer Dmitry Glukhovsky penned "*Metro 2033*," while German author Markus Heitz wrote "*The Dwarves*."

Developers at KING Art Games loved Heitz's book so much that they decided to turn it into an epic RPG. KING Art Games took to Kickstarter for funding to fill the game with all the features on its wish list. Backers received access to the alpha and beta, but now all of us are able to grab our weapons and slash/bludgeon/fireball our way through swathes of bloodthirsty orcs.

The least spoilerific spoiler of the year: You begin *The Dwarves* as a dwarf named Tungdil Bolofar. The earnest Groundling, as they're derisively called in-world, takes to smithing like a fish to water, naturally, but his love of books and learning might make him the first nerdy dwarf in all of fantasy. It doesn't take long before Tungdil's adoptive father of sorts, the human magus Lot-Ionan,

## Bearded Warriors Wielding Bearded Axes

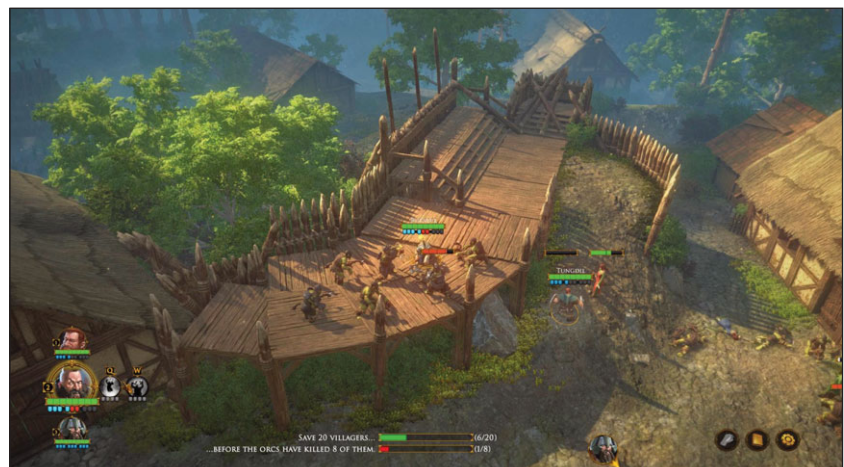
BY VINCE COGLEY

\$39.99 (PC, XOne, PS4) • ESRB: (M)ature  
THQ Nordic • [www.dwarves-game.com](http://www.dwarves-game.com)

sends Tungdil on an errand that begins his hero's journey, and in short order Tungdil finds out that there are plenty of other dwarves left in the world of Girdlegard. (Shocking, we know.) With help from a handful of Unlikely Allies, Tungdil endeavors to save the realm from the nefarious Dark Wizard.

Party members come, go, and come back, but *The Dwarves*' combat system remains the same throughout. KING Art Games delivers a reasonably tight tactical action RPG, rewarding you for pausing the action—perhaps a little too frequently—to maximize the impact of your characters' abilities. The game's camera rarely feels perfect, and a rather shallow inventory makes *The Dwarves* more of an RPG Lite in truth. On the other hand, the physics-based "brawler" elements are fresh enough that *The Dwarves*' shortcomings are forgivable.

Voice acting is quite good, and the graphics are decent if unspectacular. *The Dwarves* owes an immense debt to Tolkien, of course, and yet the story has enough heart to keep us playing. Fans of Heitz's novels will undoubtedly dig *The Dwarves* more than anyone else, but if you're up for a serviceable RPG with lots of good old-fashioned high fantasy, this game is a heaping helping of comfort food. The \$40 price tag puts it in the same class as heavyweights such as *Skyrim* and *The Witcher 3*, though, so we wouldn't blame you for greedily keeping your vault locked and waiting for a sale or discount. After all, no self-respecting dwarf would fault you for trying to save a little gold. ■







Watch Dogs 2 is an open-world sandbox-style game that will be instantly familiar to anyone who has played the first game, or any of the recent GTA, Saints Row, Just Cause, or Mafia games. All of these games are effectively third-person world simulators, complete with hundreds of NPCs milling around, dozens of miles of realistically rendered city and rural landscapes, a vast array of vehicles, massive arsenals of weaponry and gadgets, day/night cycles, and dynamic weather systems. As with other open-world games, Watch Dogs 2 gives you multiple options for completing missions: you can go in guns blazing or sneak through the back door. The player character also has a wickedly fun drone and radio-controlled buggy to disable security systems, create distractions, and neutralize threats.

Compared to those other games, and even the original Watch Dogs, this game gets a lot right. The hook for this series is that, as the protagonist, you are an elite hacker living in a near-future city (this time it's San Francisco) where an evil corporation has total control over an all-seeing and all-knowing software network that it uses to track, manipulate, and ultimately oppress the citizens therein. This Internet of Things on crack, called ctOS 2.0, isn't just your nemesis, it's also your primary means of sabotage, subterfuge, and revenge.

As Marcus Holloway, you can whip out your smartphone to script your way into and out of numerous hairy situations, for instance by changing street lights green, rupturing gas valves, exploding transformers, remotely hijacking and controlling cars, unlocking high-security doors, and more. Sure, you can play through Watch Dogs 2 much like you would GTA, by shooting up everything in sight, but it's so much more satisfying to use ctOS against your foes. The non-violent options are a nice change of pace, especially considering the fact that many of the people who oppose you are unwitting victims of the system.

But there's a tone problem in Watch Dogs 2. After being able to rely on stealth for a majority of the game, it suddenly vetoes that freedom. I enjoy piloting a chain-gun-armed robot spider as much as the next guy, but the moment feels more like a videogame trope than something Marcus would do. More to the point, Marcus vacillates between expressing sympathy for the duped masses and using his 1337 h4x0r skillz to steal money, information, and cars from the same "sheeple." We love how lighthearted Marcus and his fellow DedSec anarchists are

## Cry "OK Google" & Let Loose The Dogs Of War

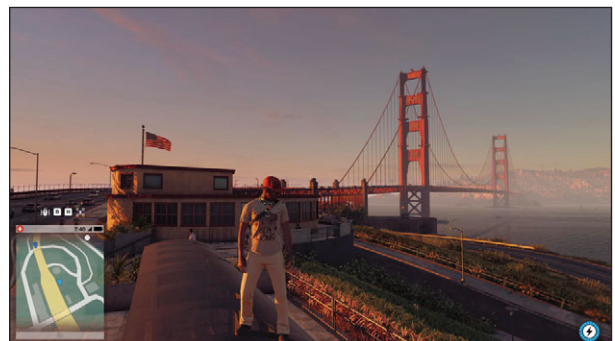
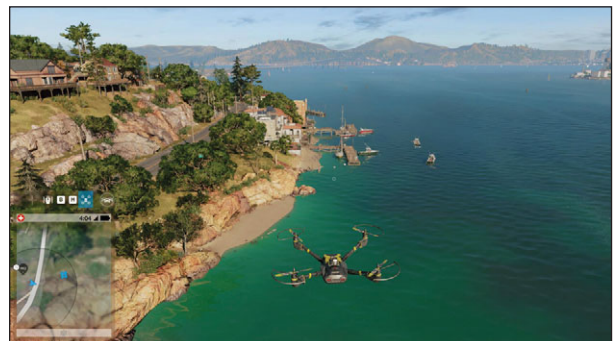
BY ANDREW LEIBMAN

\$59.99 (PC, XOne, PS4) • ESRB: (M)ature  
Ubisoft Montreal • [www.ubisoft.com](http://www.ubisoft.com)

early on, but—without wanting to spoil anything—the game veers hard from this mentality midway through and then attempts to veer back toward the end. It makes for an awkward transition.

The game has some flaws, but overall, hacking our way through San Francisco is enjoyable—significantly more so than with Aiden Pearce in Chicago, a la the original Watch Dogs. The best part of this game, however, is that it actually has something to say about our vanishing privacy, shrinking security, and increasingly constrained freedoms, and how we're so willing to click the Agree button because an infinitely connected future is just so darned convenient. OK, Google, can I have my privacy back?

Ubisoft Montreal deserves props for making the PC version feel like a premium offering. There's a high-resolution texture pack and more than 20 settings that let you tweak image quality. If your hardware can hack it, Watch Dogs 2 can look pretty amazing. ■

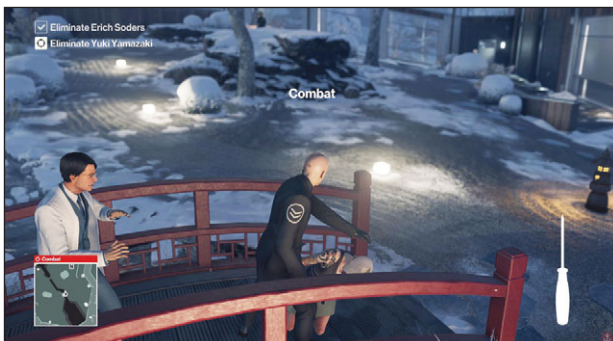




Back in our May 2016 issue, we reviewed the latest installment of the HITMAN franchise, and although we loved IO-Interactive's open-world murderfest, we were rather put off by the game's episodic release schedule. The developers effectively chopped up the game and doled out the bits as they finished working on them. Eight months after the initial release, the full game is now playable, and we can finally deliver a definitive review of the complete package.

A lot of what makes HITMAN great is present in that Intro Pack, which includes the Paris mansion level. The first time you play through a mission, you get the story cutscene, a short list of targets (usually two, but up to four), and a slew of additional objectives that crop up organically as Agent 47 slinks around what amounts to a Hobby Lobby designed for people whose only hobby is killing people. These mini objectives are designed to get you close to one of the targets and nudge you in the direction of a particular kill method. Executing them flawlessly will net you bonuses, as will finding tidbits of intel that tie into the game's narrative. They even result in unique animations. One such event had us tossing an ailing target's donor heart into a waste bin. Nothin' but net. For each target, you'll typically only get to perform a single kill objective, so you'll need to go back again and again to see them all play out. And for the most part, you'll want to.

There's real replay value in retrying the missions to see how wacky things get, and although it's also fun to blaze your own trail from time to time, nothing feels better than being able to walk calmly away from the murder scene without ever raising an eyebrow. Subsequent playthroughs get even more interesting thanks to the weapons, stash points, disguises, and starting locations you unlock with the points earned during the mission.



## It's A HIT, Man

BY ANDREW LEIBMAN

\$59.99 (PC, XOne, PS4) • ESRB: (M)ature  
IO-Interactive • [www.square-enix.com](http://www.square-enix.com)

For \$60, however, we expect a complete experience, and that wasn't available until late October. The Complete First Season, as it's currently being referred to, finally feels like a whole game. The episodes that followed the Intro Pack each serve as missions in a single exotic location, including a coastal Italian-inspired village called Sapienza, a market packed with hundreds of milling NPCs and an embassy in lockdown in the Moroccan city of Marrakesh, a luxury hotel in Bangkok, a remote militia training facility in Colorado, and a high-tech private hospital in Hokkaido, Japan. Each playground offers unique opportunities to blend in and challenges to overcome, and they're all fun places to kill bad guys.

The story side of HITMAN is a little thin, but as we went to press, we caught word that IO-Interactive is planning to move forward with a Season Two, which will hopefully amount to some real developments instead of more of Season One's tail-chasing. The game is massively fun, which is why we're so willing to forgive the slow-burn story elements.

Much has been said elsewhere about HITMAN's always-online requirement, and we'll agree it's wholly unnecessary for this exclusively single-player game. On one occasion, the servers weren't responding, keeping us from being able to log in and play the game at all. What will happen a few years from now, when the servers are shut off? We're thinking no amount of disguises or concealed tactical pistols will get 47 out of that bind.

But, for now at least, we are confident that fans of stealthy sandbox games where you play as James Bond's bald American alter ego will be very happy with this fully realized HITMAN. ■





## Q&A With Nathan Bashaw

# Bringing To Life A New Format For Mobile Storytelling

In the lead-up to creating Hardbound, CEO and Co-founder Nathan Bashaw and his colleagues asked themselves what storytelling might look like if, rather than creating a story with print in mind and then porting it to an ebook format as authors and publishers have traditionally done, they instead created stories with mobile screens specifically in mind. Doing so would enable taking advantage of a software-driven environment and all the abilities that computers afford. Essentially, Bashaw and company have created a “new form of media” with Hardbound. Twitter and Medium Founder Evan Williams has expressed his love for the format and hailed it as pushing the boundaries of mobile storytelling.

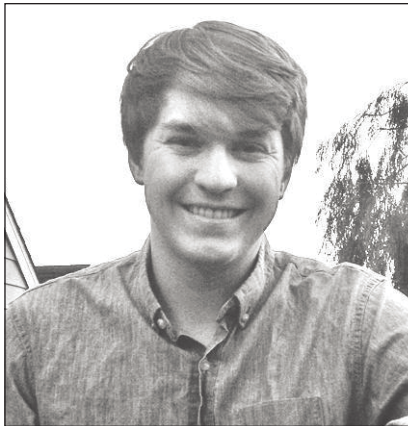
While downloading Hardbound’s free mobile app is the best way to understand the storytelling experience it’s bringing to life, think of Hardbound stories as super-charged slideshows that put text, comics, animations, and other visual elements to excellent, innovative use. Oddly, the interactive storytelling experience that Hardbound presents feels entirely new and completely familiar.

To date, Hardbound’s creators have created stories focused on “edutainment” topics, or material that’s both educational and entertaining. Soon, the company plans to open its content-creation tool to anyone, which could result in new types of content. We spoke with Bashaw—who also co-founded Product Hunt and created Dash, an interactive online book that thousands have used to learn how to create websites—about Hardbound, mobile storytelling, and more.

(You can read our entire conversation at [www.computerpoweruser.com/23968](http://www.computerpoweruser.com/23968) )

**Q:** Can you describe what the Hardbound experience is like through your eyes, from the point of opening the app to swiping through pages?

**NB:** That’s a good question. I’ve never been asked that actually. When you open the app, you see a bunch of stories that you can read, and each story is like a little square that has a title and a picture and tells you a little something about what’s inside it. Right now, all those stories you see are a part of what in the future we’ll just call “Hardbound Weekly.” So that’s just one kind of channel that we’re making. The second channel is the “Nightcap,” which is a different kind of channel that isn’t in the app yet but that’s a different kind of story. Eventually, there might be many channels. You might have a view that’s like “Your Channels” that you subscribe to. But for now, you just see the ones that are in the Hardbound Weekly, and you can tap one of those stories and it zooms you into that



story. It shows you the first page and you just see some image or text or visual and you just tap and it shows you the next thing. You just keep tapping, and every time you tap there’s an animation between the page you’re currently on and the next one. There’s some combination of visuals, animations, text, graphics, maybe data visualizations, maps, really anything. Just tap, and it shows you the next thing. That’s the rhythm you

get into, although you can also slide to go back and that sort of stuff. There are some nuances to the way it works, but the core of it is you just tap and it animates it into the next thing.

**Q:** Interacting with Hardbound stories produces this strange feeling that you’re experiencing something entirely new but very familiar. How do you describe Hardbound and the storytelling experience it provides?

**NB:** That’s a great question because it’s something that we’ve spent a lot of time trying to figure out, and I don’t know if we have a great answer for it. What I usually do if I’m physically with someone and I’m trying to explain Hardbound is say, “It’s a new format for storytelling, and it’s really visual and active and animated. It’s really made for mobile.” That’s about all I say, and then I show it to them. I feel like it’s one of those things that’s a little

bit hard to explain. I also hesitate to use the word “slideshow,” because I think the connotations of the type of content you’d normally see in a slideshow isn’t something that we want to associate ourselves with so much. We really view the content we create for this format as something closer to something you might find in a podcast or magazine article. When you think of a slideshow, you normally think of sentence fragments and a bunch of bullet points or maybe a chart or something. Our content is just not really like that, although it is based on the idea of a slideshow where there’s a sequence of images essentially that combine words and images and sometimes animation. But the way we’re using it is just so different than something you might find on SlideShare that I try not to use that. But it’s not a bad anchor point, I guess.

**Q:** You left your job on your 26th birthday citing a need to answer a question that had been nagging you: “What if books were designed for screens?” Why that particular question?

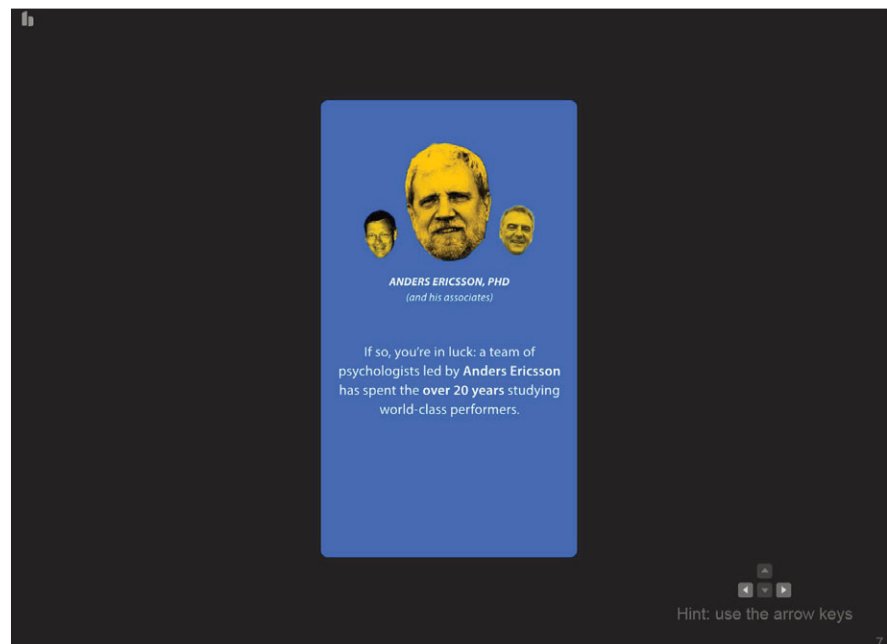
**NB:** The goal of books, the job to be done, is transferring knowledge or transferring experiences maybe in the more broad sense. I’ve just always loved that. I love books. I love watching movies. I love reading. The thought to me that a lot of what we consume are digital recreations of formats of media that were created in response to the capabilities and constraints of analog media is just—when I feel I realized that, I was like, “Wow.” It will take a while, but people will probably invent new things in the context of the devices that we actually use now and that are designed for them rather than just continue to use the internet and computers as a distribution layer that plugs into the exact same production and supply chain and activity as media creators have always done.

The job of a journalist has changed a lot, mostly because it’s gotten faster, but also with the actual content they’re creating. You can print—and people do print—the stories they make, and I think that will continue for a long time, but I also feel there’s a lot of opportunity for new stuff to get made

that couldn’t be printed or be shown on a television. YouTube could be put on your TV really easily; it’s basically the same thing, but it starts to get more and more different the further and further out we get into the future.

I think Hardbound is maybe a step in that progression in an attempt to see if you could create a media company or platform that media companies can use that’s a really brand new format, where you explicitly set out to create a new format. That was what we

transferred and you’re doing an activity, like moving your eyes across lines of text. There’s some other stuff going on, like if you’re reading off a screen, studies have shown you’re kind of engaging with the text in a different way where you’re maybe a little more distracted and you probably have trouble remembering it in the same way. Your attention span is a little shorter. These are all basically different ways of downloading information that are good at



The Hardbound format is based on the idea of a slideshow, where words combine with images, animation, and other visuals to tell a story.

spent really the first six to nine months of our company on—figuring out what the format should be. We went through a lot of ideas and a lot of our initial thinking was wrong and some of it was right, and it just took learning. We focused a lot on that at first.

**Q:** In talking about Hardbound, you’ve stated a desire to create a new form of storytelling that makes people feel awesome and “creates a super-high-bandwidth connection between their phone and brain.” What does that mean?

**NB:** Bandwidth just means the rate of information transfer. When you’re reading text, certain information is being

some things but maybe not as good at other things. Like if you just watch a video of two people talking, after a while it gets boring because you don’t really need the video. It turns out podcasts are a great medium for that because you can do whatever else, like fold the clothes or take a walk or go to the gym or something. You don’t need your eyes, so it only uses the channels it needs.

To me, with the format of Hardbound, we wanted to create something that you can learn more in a faster period and stay engaged better by how this information is presented. It’s the way your brain works better. There are a couple of principles of psychology—we kind of realized some of this after the fact, some of it was



intentionally baked in—that explain why it feels good to read a Hardbound story. The first one is progressive disclosure, which basically means if you, say, have three things to tell someone, if you show them all three things at once they won't comprehend it or remember it as well as if you show them one at a time. It's really simple. You focus people by showing them a smaller amount of information at any given time. I think Hardbound does that well, and that's one of the reasons why it's good. We show a little bit of information at a time, and it just focuses you.

Another is visual primacy. So, 25% of your brain is just pure visual-information processing, and I think it's the biggest zone of the brain. We're just really good at recognizing objects, recognizing motion. Part of what we started to do in the Hardbound app, and it works really well, is when you tap and it animates to the next slide, the way the motion is designed kind of guides your eyes to where the next text is going to be. It feels really smooth. We started doing that more explicitly. That kind of stuff just happens at such a deep level in your brain. Just seeing faces, like seeing processing in motion, getting the lay of the land through a map or something, or seeing a setting.

In one of the news stories in The Nightcap [essentially a channel of content], basically the president of Syria did a rare interview from his palace, which is pictured. You see a picture of where he lives, his palace. That's so much more meaningful than just imagining what it would be like. And you probably wouldn't bother to look it up. But now you have such a more visceral understanding of what the palace actually looks like and what the news event was because you kind of picture it.

I think visual primacy and progressive disclosure are some of the things that make Hardbound create a better connection. It takes the way your brain works and kind of designs around that using the screen as the constraint. VR, for example, is a different constraint but maybe feels even more like reality, but it's also expensive because you have headsets and you're also not in current reality. It asks a lot of you. Hardbound doesn't ask quite as much, and it works

with existing technology that a lot of people use. I think VR is another example of a new medium, and a lot of companies are working on VR. There's a lot of hype. Hardbound is kind of a weirder, unique thing without as much hype but hopefully becomes something a lot of people like.



Hardbound features “edutainment” articles covering various topics that should remain relevant for a long time.

**Q:** You wrote that one goal for Hardbound is becoming a platform on which creators, such as novelists, podcasters, journalists, and educators, can aim high. Is there a fear that Hardbound could inspire similar platforms featuring content with less lofty ambitions?

**NB:** It's interesting because where I sit now, that would be the greatest problem to have—that there's just a ton of stuff that gets created for it and there's some stuff that I don't like. From where I sit right now, I'm not afraid of that at all. If that actually happened, how I feel about it might be a little bit more viscerally different, but I kind of take the perspective that probably

a lot of tech companies do, where there's a minimal standard that you have to meet where the content is basically not abusive or pornographic or something like that. That doesn't mean everything on here has to be good, but that being said, it is critically important that when users open up the app, they're presented with things that they're going to love. If nobody loves it, we probably shouldn't show it to that many people. So I'm really concerned about that, but it's a different question. It's not, “Should it be on here at all?” It's, “Just how prominently should it be displayed and to whom?” That feels like a more solvable problem almost. You can make product decisions that help surface the best things to the people who are going to want it the most rather than thinking about it like it shouldn't be listed on here or be included at all.

**Q:** How far along is Hardbound now compared to where you believe it can end up?

**NB:** We just want to make this really cool thing that provides a lot of value to a lot of people. The sky is kind of the limit. You can imagine it being an enduring, lasting company that adds a lot of value to a lot of people's lives, but I don't even know if it's useful to think about that because it's so far away from us. The goal is to be as great as it can possibly be. If you imagine the things of the past, there have been some pretty amazing things, so it has shown what was possible. And I also don't think we've seen what the biggest, best company on Earth can look like. I don't think necessarily bigger is better, but there's probably more possible than what has been done.

I think we'll be on track if a couple of years from now, like what's happened with podcasts in the past five years, if Hardbound sort of feels like that, where it's a form of storytelling that's new but familiar and there's a lot of great stuff being created for it by individuals and media companies and it is just something that a lot of people are starting to enjoy. So even if we can do that, it would be a huge thing. But if we can do that, then we're in a position to do a lot more. I wouldn't define that as the stopping point. ■

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**01.06-08.17**

LANFest MLP'017 Winter  
Hamburg, NY  
[massivelan.com](http://massivelan.com)

**01.07-08.17**

River Valley LAN  
Russellville, AR  
[www.elayin.com](http://www.elayin.com)

**01.20-22.17**

FADECON  
Garland, TX  
[www.fadecon.org/next-event](http://www.fadecon.org/next-event)

**01.20-22.17**

Kansas LAN XII  
Lyons, KS  
[www.facebook.com/kansaslan](http://www.facebook.com/kansaslan)

**01.21.17**

Oklahoma Gamers Group  
Oklahoma City, OK  
[www.okgg.org](http://www.okgg.org)

**01.21.17**

Underground Gaming  
Ashland, OH  
[www.facebook.com/groups/UGGeSports](http://www.facebook.com/groups/UGGeSports)

**01.27-29.17**

PAX South\*  
San Antonio, TX  
[www.paxsite.com](http://www.paxsite.com)

**02.04.17**

CEGCON 2017  
Big Rapids, MI  
[ceg.ferris.edu](http://ceg.ferris.edu)

**02.16-19.17**

PDXLAN 29\*  
Portland, OR  
[www.lanreg.org/pdxlan/pdx29](http://www.lanreg.org/pdxlan/pdx29)

**02.17-19.17**

Forever-A-LAN  
Menomonie, WI  
[pong.uwstout.edu](http://pong.uwstout.edu)

**02.18.17**

Oklahoma Gamers Group  
Oklahoma City, OK  
[www.okgg.org](http://www.okgg.org)

**02.18.17**

Underground Gaming  
Ashland, OH  
[www.facebook.com/groups/UGGeSports](http://www.facebook.com/groups/UGGeSports)

**02.24.17**

CogLAN 2.0  
Columbus, OH  
[coglan.org](http://coglan.org)

**02.24-26.17**

MidWestLAN2017: Arctic Warfare  
Middleton, WI  
[midwestlan.com](http://midwestlan.com)

**02.25-26.17**

ETSU-Con LAN  
Johnson City, TN  
[esports.etsu.edu](http://esports.etsu.edu)

**02.25.17**

Wichita LAN  
Wichita, KS  
[www.wichitalan.com](http://www.wichitalan.com)

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\* Event scheduled to include a *CPU* case mod contest

**03.03-05.17**

RGBLAN  
Philadelphia, PA  
[www.rgblan.org](http://www.rgblan.org)

**03.10-12.17**

PAX East\*  
Boston, MA  
[www.paxsite.com](http://www.paxsite.com)

**03.16-18.17**

SXSW Gaming Expo  
Austin, TX  
[www.sxsw.com/exhibitions/gaming-expo](http://www.sxsw.com/exhibitions/gaming-expo)

**03.18-19.17**

LANOC v20.0  
Van Wert, OH  
[lanoc.org/lan-parties](http://lanoc.org/lan-parties)

**03.18.17**

Oklahoma Gamers Group  
Oklahoma City, OK  
[www.okgg.org](http://www.okgg.org)

**03.18.17**

Underground Gaming  
Ashland, OH  
[www.facebook.com/groups/UGGeSports](http://www.facebook.com/groups/UGGeSports)

**03.24-26.17**

PONG March LAN  
Menomonie, WI  
[pong.uwstout.edu](http://pong.uwstout.edu)

**03.31-04.3.17**

ATRLAN 2017  
Troy, NY  
[www.facebook.com/events/600287063477170](http://www.facebook.com/events/600287063477170)

**04.01-02.17**

Gamers for Giving 2017  
Ypsilanti, MI  
[www.GamersforGiving.org](http://www.GamersforGiving.org)

**04.07-09.17**

VectorLAN 8  
Portland, OR  
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Underground Gaming  
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[www.facebook.com/groups/UGGeSports](http://www.facebook.com/groups/UGGeSports)

**04.22-23.17**

Ultimate Gamer Showdown 3  
Dauphin, MB  
[www.aybonline.com](http://www.aybonline.com)

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DREAMHACK Austin 2017  
Austin, TX  
[austin.dreamhack.com/17](http://austin.dreamhack.com/17)

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## Q&A With Julian Castro

### Obey Alliance CEO

### On The Alliance & DXRacer

**Q:** Hi Julian! Can you explain what Obey Alliance is for readers who might not be familiar? What does Obey do, and how did it get started?

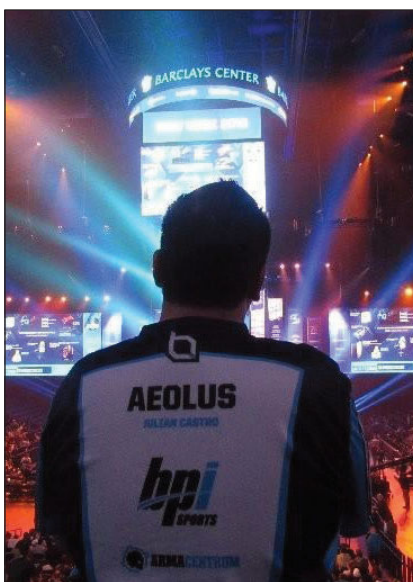
**JC:** Obey Alliance is a gaming organization founded upon montage content from the popular FPS title Call of Duty. After years of content creation specifically on that platform, in 2016 Obey has expanded to eSports as well as CS:GO and Battlefield content. Whilst still remaining true to the roots of our content, we look to expand and innovate as an organization into new and exciting games.

**Q:** How many eSports teams and/or players do you currently have on the Obey roster?

**JC:** Currently, about three months into our push to develop a solid eSports ground, there are two paths we have stepped into. One from SMITE, which actually just qualified for SMITE Worlds early this January. This was the first team we acquired and honestly has been a great experience. SMITE is an amazing community with passionate players and a strong support system through an outstanding company in Hi-Rez. When looking to find our next pickups in eSports, that is specifically what we look for: people with the same passion we all have for gaming, to work toward a similar goal. This led us to our second acquisition, Smash Melee Player Mike Haze. Mike is incredible; not only is he great in the competitive scene, but he creates great content during his off time.



Castro in civilian attire (above) and rocking his Aeolus Obey gear at an eSports event (below).



Being an organization with a foundation based on content creation, we look to really synergize Mike into our channel come 2017.

**Q:** How many members does Obey have?

**JC:** Obey currently has about 60 or more members. This is because of the different sections that have been developed in Obey to accommodate our content side. We have creators that develop specific forms of content, with lead directors managing each specific form. On top of content, we have developed our own design studio and video-editing team. This has created a well-oiled machine that constantly produces content and lays the foundation for what Obey is. Especially going into eSports, the design studio has been extremely essential, and we look forward to creating new opportunities in 2017 for all the hard-working creators in Obey.

**Q:** What would you say is the No. 1 reason people join Obey Alliance?

**JC:** Obey is not only one of the biggest teams to look to join on YouTube, but our structure is the key reason for our success. Management works hard to work with our creators to help them grow and benefit from their passion. Given our size on YouTube and Twitter, we have the type of influence in our community to help grow any individual. Many creators have amazing talent. However, they need guidance on taking their passion to the next level. Obey is the place to be for creators that want a positive experience of growth



with people who share their passion for creation and gaming.

**Q** : So, you work with manufacturers to secure discounts to advertise to your fan base; what has Obey's experience with DXRacer been like, and how did that start?

**JC** : DXRacer has always been the best chair in the gaming community. This has been an established standard for a long time. When looking for new partners to develop with, we knew DXRacer would be a partner that Obey would love to have. DXRacer worked with our design studio to create advertising that optimally pushed DXRacer products to our fan base, not only through our platform on YouTube but also on Twitter. Due to all these factors, our partnership with DXRacer has always been great. To work with a company that is run by individuals who take time to understand our process is a treat, and they have always worked with us to make the most out of our partnership together.

**Q** : How have Obey members responded to DXRacer, both in terms of the discounts you've worked out with the company, as well as with the chairs themselves?

**JC** : Our members love DXRacer, and since our partnership with DXRacer has been so successful, we have been able to give product as rewards to creators that work hard every day to grow Obey and themselves. It is important for us to work with a brand that we know our members will love, and given DXRacer's reputation, when this was originally released, everyone was ecstatic. DXRacer also has made amazing efforts to understand the content being produced and work with us on strategies for integration accordingly.

**Q** : And you have also partnered with DXRacer on a custom Obey Alliance chair, right? How did that go down, and what was the process like?

**JC** : Yes, the Obey Alliance chair is now finally available. It was a process, but the process was enjoyable given what we were working toward. DXRacer gave a chair design template to a designer in our organization. Once the chair was designed, finalizing colors and changes to the design took some time. Obey and DXRacer were always in contact during this process, and after a couple of months, we had a finalized product we were proud to have as Obey's team chair.

**Q** : Cool, thanks for your time! What's the best place for readers to go for information about Obey if they're interested in joining?

**JC** : The best place to follow and look at new opportunities to be a part of our organization would be on Twitter ([twitter.com/theobeyalliance](https://twitter.com/theobeyalliance)), and if you want to stay updated on content, you can subscribe to our YouTube channel ([www.youtube.com/user/ObeyAlliance](https://www.youtube.com/user/ObeyAlliance))! ■



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